Aviation Week and Space Technology

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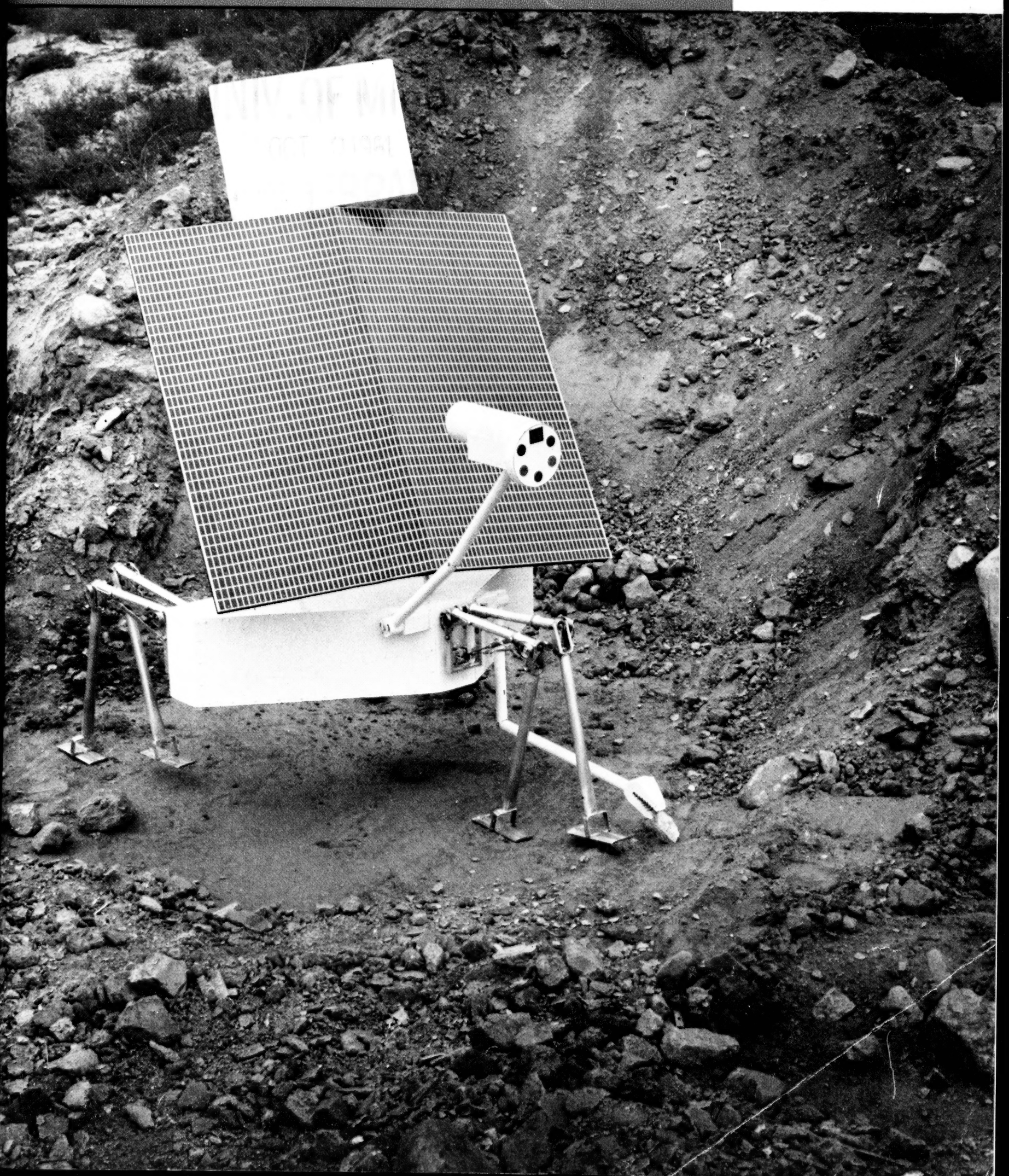
A McGraw-Hill Publication

October 9, 1961

SPECIAL REPORT:

Lockheed C-141 Development Program

Model of Space-General Roving Lunar Vehicle



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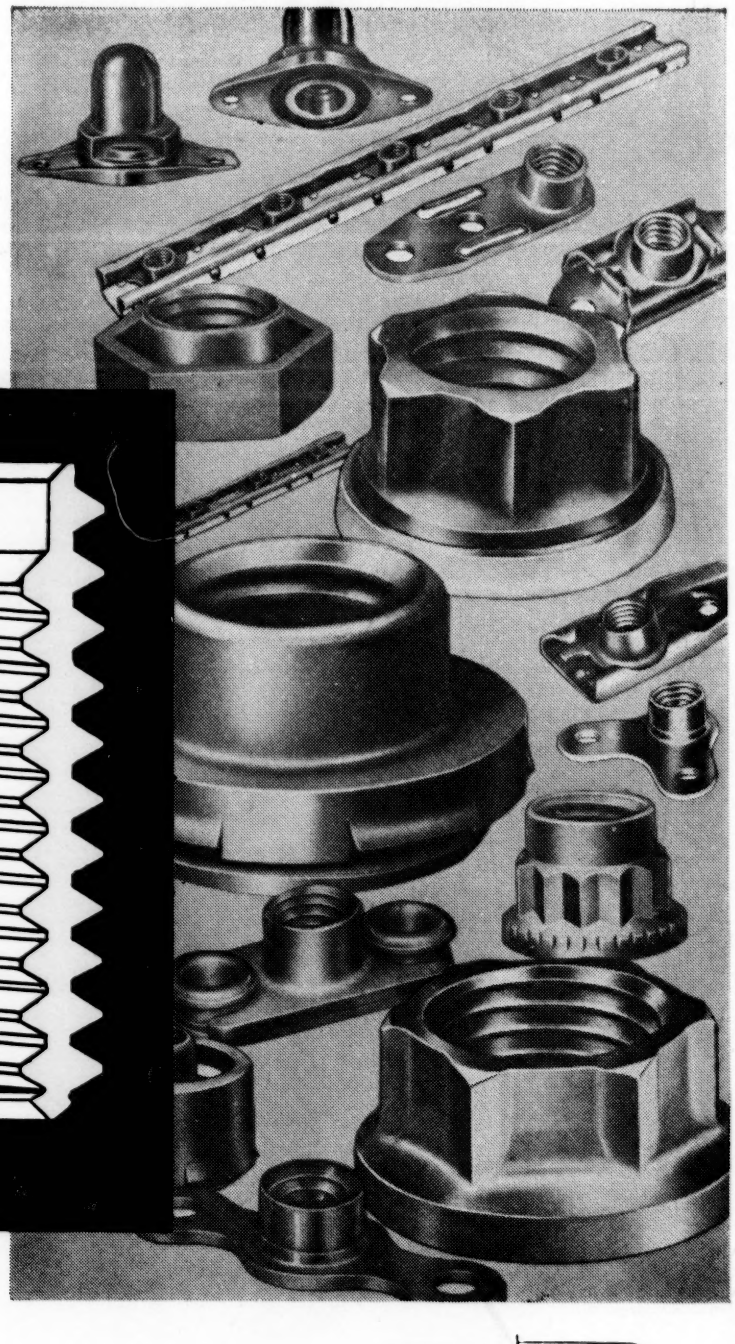

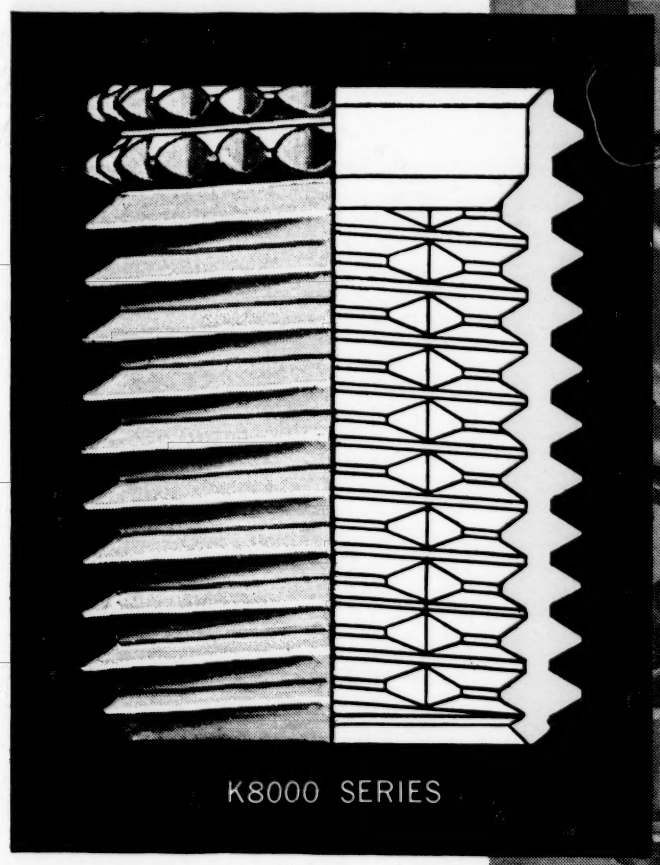

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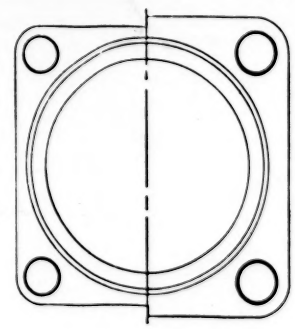

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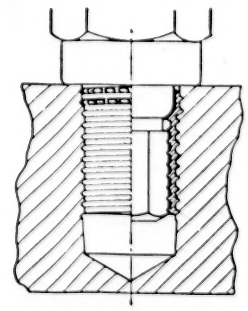

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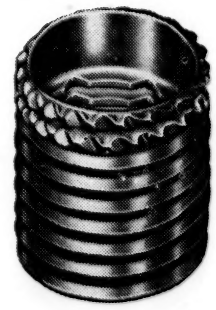

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AVIATION CALENDAR

Oct. 16-19—Eighth Annual Symposium, American Vacuum Society, and Second International Congress, International Organization for Vacuum Science and Technology, Sheraton-Park Hotel, Washington, D. C.

Oct. 17-19—Lubrication Conference, Morrison Hotel, Chicago, Ill. Sponsors: American Society of Lubrication Engineers; American Society of Mechanical Engineers.

Oct. 17-19—Seminar on Terrain-Avoidance (Secret), Cornell Aeronautical Laboratory, Buffalo, N. Y.

Oct. 18-19—Ninth Annual Safety Forum, Air Line Pilots Assn., Del Prado Hotel, Chicago, Ill.

Oct. 19—General Aviation Safety Committee, National Safety Council, Conrad Hilton Hotel, Chicago, Ill.

Oct. 19-20—National Conference on Industrial Hydraulics, Sherman Hotel, Chicago, Ill.

Oct. 23-24—Joint Meeting, Canadian Aeronautical Institute/Institute of the Aerospace Sciences, Ottawa, Canada.

Oct. 23-24—International Airline Navigators Council, European Regional Meeting, Paris, France.

Oct. 23-25—East Coast Conference on Aerospace and Navigational Electronics, Institute of Radio Engineers, Lord Baltimore Hotel, Baltimore, Md.

Oct. 23-27—17th Annual General Meeting, International Air Transport Assn., Sydney.

Oct. 23-Nov. 3—William Tell 1961, USAF

(*Continued on page 6*)

AVIATION WEEK and Space Technology

October 9, 1961

Vol. 75, No. 15

Published weekly with an additional issue in December by McGraw-Hill Publishing Company, James H. McGraw (1860-1948), Founder. See panel below for directions regarding subscription or change of address. **Executive, Editorial, Circulation and Advertising Offices: McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y.** Printed at Albany, N. Y. OFFICERS OF THE PUBLICATIONS DIVISION: Nelson L. Bond, President; Shelton Fisher, Wallace F. Traendly, Senior Vice Presidents; John R. Callaham, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator; Daniel F. Crowley, Vice President and Controller. OFFICERS OF THE CORPORATION: Donald C. McGraw, President; Hugh J. Kelly, Harry L. Waddell, Executive Vice Presidents; L. Keith Goodrich, Executive Vice President and Treasurer; John J. Cooke, Vice President and Secretary.

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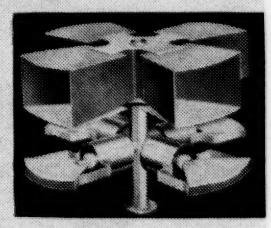

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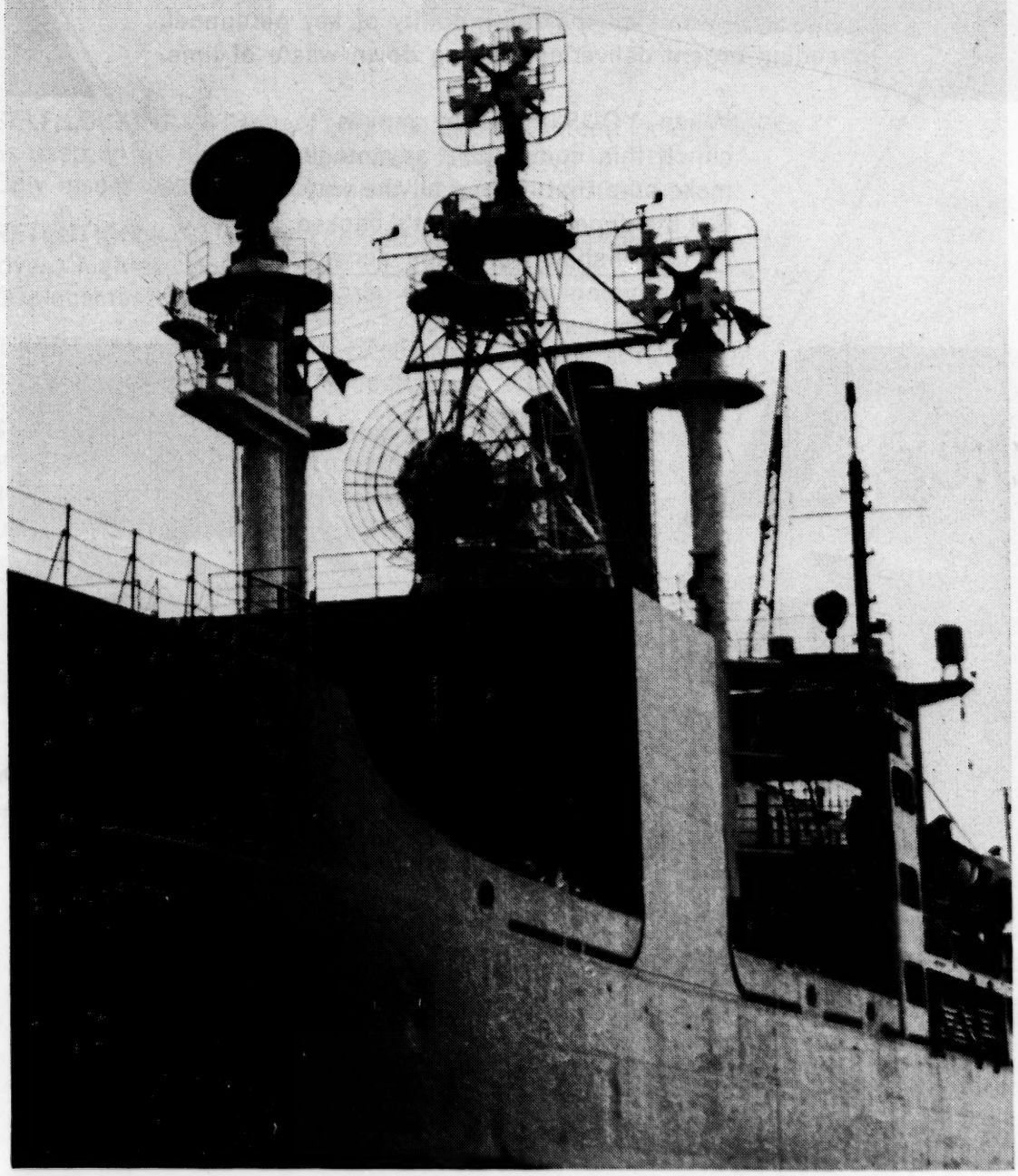

AVIATION CALENDAR

(Continued from page 5)

Interceptor Weapons Meet, Tyndall AFB, Fla. Host: Air Defense Command.

Oct. 24-26—Air Traffic Conference, Air Transport Assn., Marriott Twin Bridges Motor Hotel, Washington, D. C.

Oct. 24-26—International Symposium on Aero-Space Nuclear Propulsion, IRE, Riviera Hotel, Las Vegas, Nev.

Oct. 24-26—Air Transport Assn.'s Engineering and Maintenance Operators Meeting, Americana Hotel, Miami Beach, Fla.

Oct. 25-27—Annual Convention, Southeastern Airport Managers' Assn., Penn Hotel, Monroe, La.

Oct. 25-27—Joint Electronics Division-Pacific Coast Regional Meeting, American Ceramic Society, Jack Tar Hotel, San Francisco, Calif.

Oct. 26-27—Quarterly Regional Meeting, Assn. of Local Transport Airlines, Sahara Hotel, Las Vegas, Nev.

Oct. 26-27—Third Annual Symposium on High-Speed Testing, Hotel Somerset, Boston, Mass. Sponsor: Plas-Tech Equipment Corp.

Oct. 26-28—Electron Devices Meeting, Institute of Radio Engineers, Sheraton-Park Hotel, Washington, D. C.

Oct. 29-31—International Symposium on Photoelasticity, Illinois Institute of Technology, Chicago, Ill.

Oct. 30-31—Aero/Space Fluid Power Conference, Pick-Fort Shelby Hotel, Detroit, Mich. Sponsor: Aero Hydraulics Division of Vickers, Inc.

Oct. 30-Nov. 1—Annual Meeting, Air Traffic Control Assn., Deauville Hotel, Miami Beach, Fla.

Oct. 30-Nov. 1—Technical Symposium on Aerothermoelasticity, Biltmore Hotel, Dayton, Ohio. Sponsor: Aeronautical Systems Division, Air Force Systems Command.

Nov. 1-3—First International Congress on Experimental Mechanics, Society for Experimental Stress Analysis, Hotel New Yorker, New York, N. Y.

Nov. 1-3—"Issues and Challenges of Air Transportation" Symposium, Hartford, Conn. Sponsor: Connecticut General Life Insurance Co.

Nov. 6-8—Special Technical Conference on Non-Linear Magnetics, Institute of Radio Engineers, Statler Hilton Hotel, Los Angeles, Calif.

Nov. 6-9—1961 Conference and AtomFair, Atomic Industrial Forum and American Nuclear Society, Conrad Hilton Hotel, Chicago, Ill.

Nov. 9-10—Fifth Annual Display, Aerospace Electrical Society of San Diego, Balboa Park, San Diego, Calif.

Nov. 9-10—11th National Conference, Aircraft and Missiles Division, American Society for Quality Control, Ambassador Hotel, Los Angeles, Calif.

Nov. 14-16—Northeast Electronics Research and Engineering Meeting, Institute of Radio Engineers, Commonwealth Armory and Somerset Hotel, Boston, Mass.

Nov. 28-30—38th Meeting, Aviation Distributors and Manufacturers Assn., Jung Hotel, New Orleans, La.

Dec. 5-7—Annual Convention, National Aviation Trades Assn., Statler Hilton Hotel, Washington, D. C.

October 9, 1961

Aviation Week and Space Technology

Vol. 75, No. 15
Member ABP and ABC

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Soviets, U. S. Call for Space Cooperation **22**
▶12th International Astronautical Congress is told that Russia might some day launch joint payloads.

Airlines Split on Foreign Carrier Curbs **36**
▶Proposed legislation to control capacity and rates creates division over extent of government's role.

Flow of C-141 Subcontracting Under Way **50**
▶Development of Lockheed turbofan airfreighter for USAF is on schedule; $500 million of subcontracts ultimately will be awarded.

SPACE TECHNOLOGY
Soviet, U. S. Space Cooperation..... 22
Soviet Delegation to IAF..... 22
U. S., Russian Venus Measurements.. 23
Johnson Tours Space Stations..... 26
Booster for British Satellite Switched 27
Satellite Drift Data..... 29
Transit IV-A Proves Equator Elliptical 33
Roving Vehicle Control Poses Problems 71

AERONAUTICAL ENGINEERING
Sikorsky Assault Transport 'Copter... 24
B-101C Design Changes..... 26
X-15 Flys Without Ventral Fin..... 35
Flow of C-141 Subcontracting Begins. 50
Rolls Studies Lift-Jet Applications.... 67
Lightnings' Farnborough Acrobatics.. 88
Production Briefing 97

AVIONICS
Waste Reported in Electronic Projects 27
Inertial Unit Cuts Complexity 81
Filter Center 84

BUSINESS FLYING
FAA Proposes Gyroplane Rating 35

AIR TRANSPORT
Airlines Split on Foreign Carrier Curbs 36
Unprofitable Promotional Fares' Clash 37
Major Hydraulics Changes Urged..... 39
British-Run School Trains Airline Pilots 41
BOAC Sees Loss This Fiscal Year..... 43
Subsidy Cut for Central Airlines..... 43
Shortlines 48
Airline Observer 48

MANAGEMENT
6.5-Billion TFX Program..... 24
European Space Club Snag..... 27
Hayward Scores Glossy R&D Proposals 28
Defense to Speed Weapons..... 29
Priority Military Space Pace Urged... 30
SAC Planes Rated in Competition.... 91
Who's Where 19
Industry Observer 19
Washington Roundup 21
News Digest 35

SAFETY
Icing Caused Capital Viscount Crash. 99

Calendar 5
Letters 114

EDITORIAL
Toward Genuine Competition..... 17

COVER: Full-scale mockup shows configuration of lightweight roving lunar vehicle designed and developed by Space-General Corp. Final version of the vehicle is expected to weigh 135 lb. (on earth) and will be capable of being carried to the moon on National Aeronautics and Space Administration-Hughes Aircraft Co. stationary lunar vehicle Surveyor. Model was built to test operation of the legs. Remaining appendages on this model (the solar cell panel, TV camera, manipulator arm and arm with TV camera) are all dummies. See p. 71 for the conclusion of article on roving lunar vehicles which began in Aviation Week, Oct. 2, p. 52.

PICTURE CREDITS

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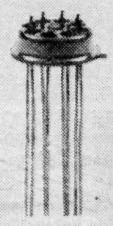

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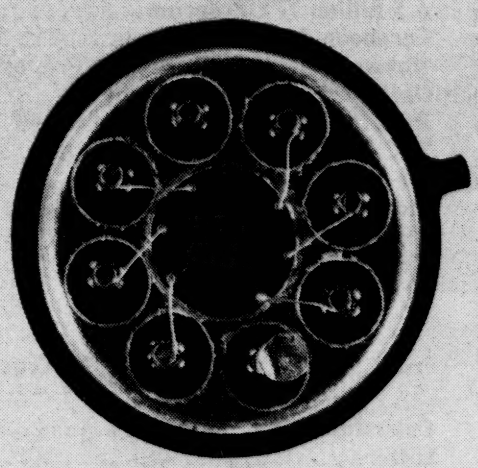

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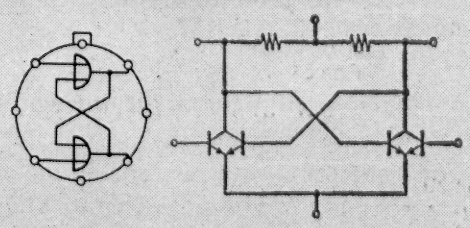

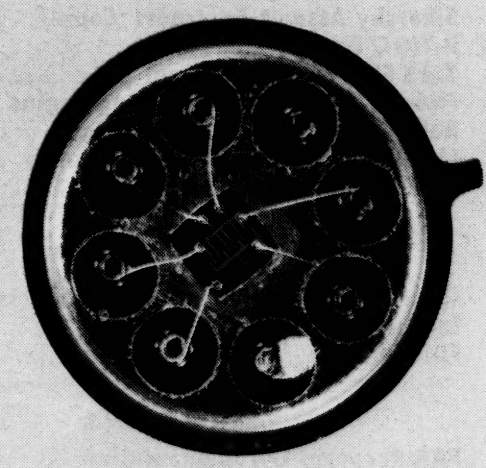

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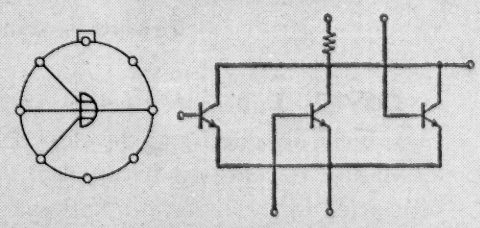

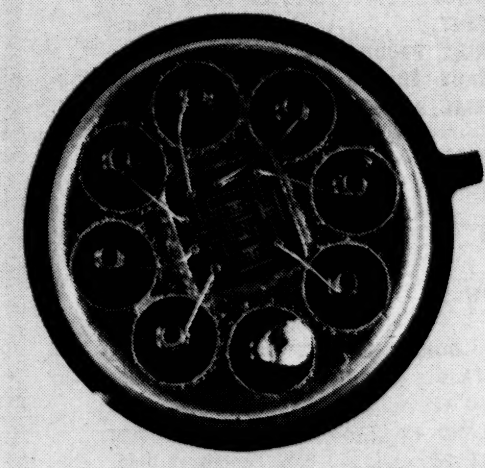

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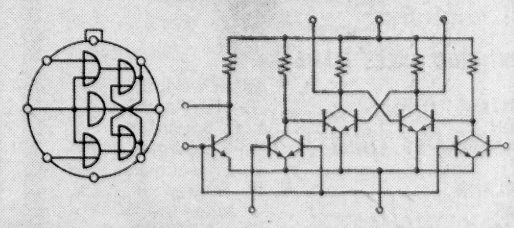

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EDITORIAL

Toward Genuine Competition

One of the key problems in conceiving, developing and producing the new technically complex weapon systems required for modern military forces has been the lack of genuine competition in the critical phases of this cycle. As the systems have grown more technically complex and expensive the areas of competition have diminished in the key phases of prototype development and production and tended to concentrate on the initial conceptual phase. Vice Adm. John T. Hayward, deputy chief of naval operations for development, performed a significant service recently in a New York speech when he turned the public spotlight on this problem (see p. 28).

The government, through Congress, and the civilian superstructure in the Pentagon and the military services must share equal responsibility with industry for this trend. As Adm. Hayward pointed out, this trend now results in most of the competitive element of any new weapon systems development program being concentrated on the proposal stage, where there is the least possibility for any genuine competition. This type of competition can easily degenerate into a high-powered lying contest distinguished by the most glittering technical double-talk, or a triumph of brochuremanship, where the best artwork and most elaborate charts turn the tide. We well remember the outraged ire of one Navy admiral who was still steaming a week later over the attempts of a top corporate official of an engine manufacturer to sell the Navy a new turbojet development solely on the basis of a beautiful watercolor conception of the externals of this machine and a set of "more thrust for less fuel" specifications, unsupported by the faintest trace of engineering data. There is also a school of industrial sales that banks on the "let's promise them anything to get our foot in the door and we can load them up with costs later" technique to gather the initial development contract, and then apply realism to the contracting service after the competition has evaporated and they sit in the sole-source seat.

On the other hand, the services have been encouraging the shift of competition to this proposal phase as weapon systems become more costly and technically complex, because it makes their budgeteers and the congressional watchdogs happier by appearing to be less expensive than running parallel competitive development programs through at least the early hardware testing stages. And although Congress is always beating its breast publicly for more competition in military procurement, it never fails to belabor service chiefs, when they try to achieve genuine technical competition, for their allegedly "wasteful duplication." The fact that the cost of preparing the tremendously (and needlessly) detailed proposals for new weapon competitions is running into astronomical figures—eventually passed back to the government by one accounting technique or another—seems to escape these congressional economists and advocates of the competitive free enterprise system.

They also fail to consider the tremendous stack of taxpayers' dollars wasted on what Adm. Hayward calls "turkey row"—programs that failed because of a lack of genuine technical competition in their development phase. Another waste factor in the competitive brochuremanship is the huge number of engineering man hours that are wasted annually in preparing the unsuccessful proposals. If this talent was applied to the solution of the many problems arising in the development cycle, instead of producing glamorous theory dressed in engineering trappings for proposals, our technical progress would indeed be accelerated.

On the surface, this trend toward making the proposal phase the only competitive arena may appear to be efficient and economical, but in fact it is wasteful of both money and technical talent and too often produces another addition to "turkey row" instead of a combat-ready weapon system or significant component thereof.

As Adm. Hayward emphasized, there is abundant evidence in "turkey row" and in some new turkeys still being hatched that no one administrator or committee can be very successful at picking winners at the brochuremanship phase. However, experience has also shown that it is relatively simple to judge the comparative performance of competing systems when they reach the early hardware stages. We heartily agree with Adm. Hayward and the other military technicians who have supported his view that prototypes are better competitors than paper proposals, and offer more genuine economy and combat effectiveness than the cheap illusions presented by the single source concept.

In addition to creating genuine competition in the main weapon system by building and testing prototypes, there is also a problem in maintaining this type of hard technical and economic competition down through the major subsystems and component developers. Too often, radically new technical steps have been attempted without laying a sufficiently broad foundation of development through these subsystems and components. This, too, has been amply demonstrated to be false economy.

We have two current examples where the competition is being limited to brochuremanship, and with all due respect to the best brochuremen, the results will inevitably cost more, take longer and produce a less satisfactory technical result even if they avoid becoming additions to a permanent perch on "turkey row." This is in the military V/STOL transport and the tactical fighter programs. To an accountant's mind the single source selection after a bitter battle of baloney in the brochure phase may appear to be a tidy and logical solution. But 58 years of aeronautical development history have proved this theory to be a mirage.

If we truly believe in the competitive merits of the free enterprise system, let's invest a little more money in some competitive prototype development in both prime and subsystem developer tiers and stop wasting infinitely larger sums in vast production programs of technically inferior and unreliable hardware for the combat inventory.

—Robert Hotz

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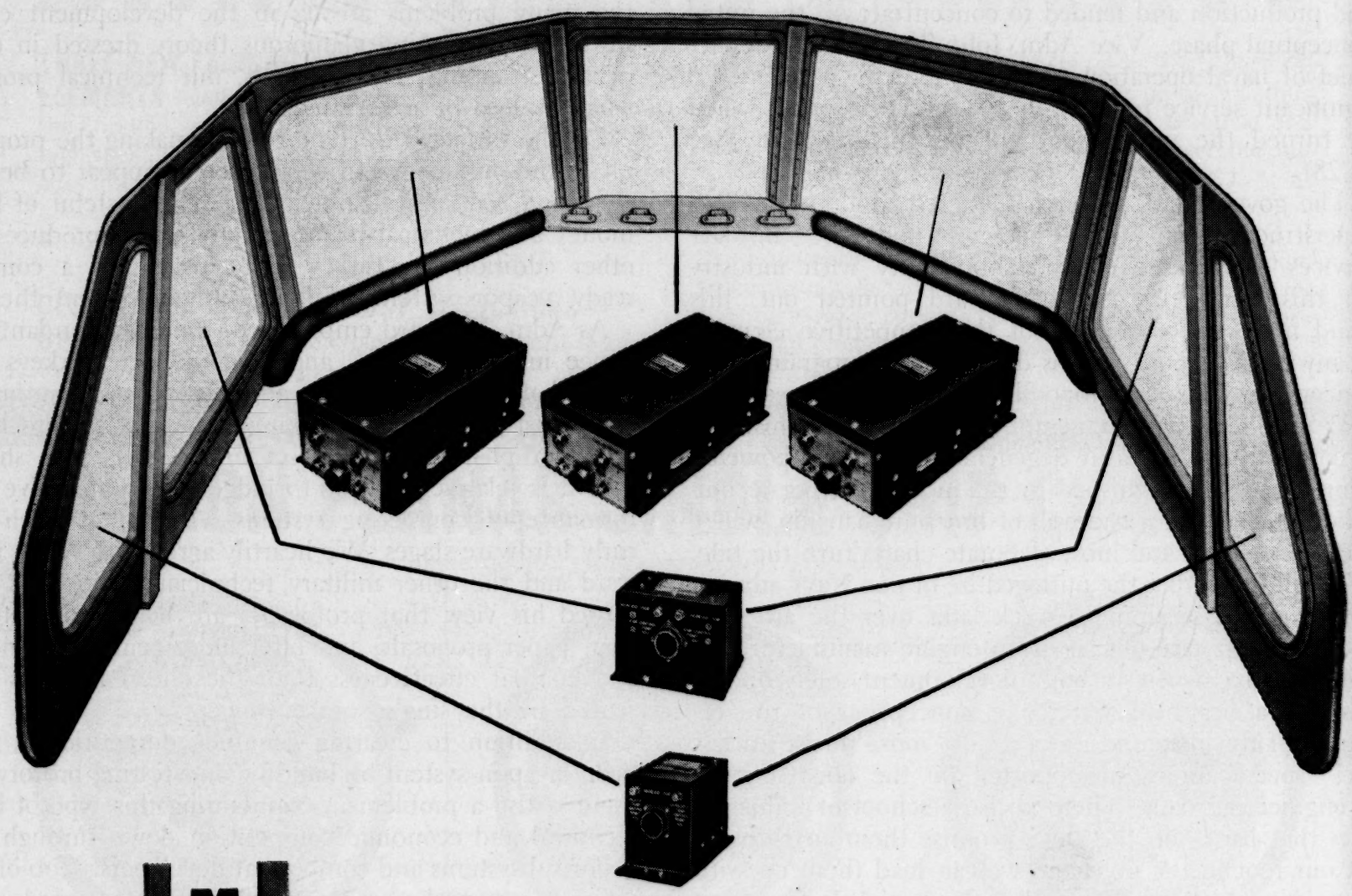

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WHO'S WHERE

In the Front Office

M. L. Doelz, a director, Collins Radio Co., Dallas, Tex. Mr. Doelz is vice president and general manager of the company's Information Science Center.

Neil M. Blair, president of Amphenol-Borg Electronics Corp.'s newly established FXR Division, Danbury, Conn.

John J. Brogan, executive vice president, Cleveland Pneumatic Industries, Inc., Cleveland, Ohio.

George E. Keck, executive vice president-operations, United Air Lines, Inc. Also: **Fred A. Brown,** senior vice president-transportation, succeeding **D. F. Magarrell,** retiring; **P. A. Wood,** vice president-base maintenance, San Francisco; **C. E. Haneline,** vice president-transportation services-East; **Warren E. Alberts,** vice president-management services and controls.

J. J. O'Brien, a vice president of The Garrett Corp., Los Angeles, Calif. Mr. O'Brien continues as manager of Garrett's AiResearch Manufacturing Division of Arizona. Also: **Jack Lewis,** vice president-manufacturing.

Elmer E. Stuart, treasurer, Thompson Ramo Wooldridge, Inc., Los Angeles, Calif., succeeding **Ernest C. Brelsford,** now vice president-finance.

J. Loring Campbell, vice president-finance and controller, Link Division of General Precision, Inc., Binghamton, N. Y.

L. John Eichner, assistant vice president-planning, Finance and Planning Department, American Airlines, Inc.

D. E. Egan, assistant to the president of Rocketdyne, a division of North American Aviation, Inc., Canoga Park, Calif.

Honors and Elections

Gerald J. Lynch, vice president of Ford Motor Co.'s Defense Products Group and general manager of the Aeronutronic Division, has been elected chairman of the board of trustees of the National Security Industrial Assn. **E. V. Huggins,** chairman of the executive committee and vice president of Westinghouse Electric Corp., was re-elected president. **Thomas Meloy,** board chairman of Melpar, Inc., was elected first vice president.

Changes

Wayne D. Stinnett, Nerva program technical manager, Aerojet-General Corp., Azusa, Calif.

Laurence V. Urgelles, supervisor of B-58 Hustler field support, Product Support Organization of Sylvania Electric Products, Inc., Buffalo, N. Y.

Hubert K. Gagos, public relations manager, Aircraft Division, Douglas Aircraft Co., Inc., Santa Monica, Calif.

Allen C. Munster, general manager of the newly established Data Recognition Department of the Communications and Weapons Division, Government & Industrial Group, Philco Corp., Philadelphia, Pa. Also: **Chester P. Woodward,** director of engineering, and **Joseph S. Norcross,** assistant director of engineering; **William Spangler,** sales manager.

INDUSTRY OBSERVER

► Beam-riding missile guidance system that would employ a narrow beam of light produced by an optical maser, rather than a radio beam, may be used in at least one major tactical weapon system. Advantages would be the extremely high resolution made possible by the maser's highly collimated light beam, and the difficulty in jamming the maser.

► **Air Force has retarded the schedule for the Douglas Aircraft Co.'s Skybolt air-launched ballistic missile to allow development of the missile, which has been lagging, to meet a revised timetable. Skybolt program now is being run by Harold E. Bauer, the third successive program manager to be named in one year. Previous managers were replaced because of failure of the missile to meet schedules, not because of cost overruns, which also have bothered the project.**

► Lunar satellite that could circle the moon, obtain high resolution maps and return to earth is being evaluated by NASA Jet Propulsion Laboratory. Proposed by Space Technology Laboratories, the satellite would be based largely on existing technology. Proponents believe it could supply useful data in two years. Satellite is not related to the lunar orbiter planned for launching in the Surveyor program (AW Oct. 17, p. 27). Latter would transmit data back to earth but would not be recoverable, and reconstituted pictures would be of lower quality.

► **NASA's Jet Propulsion Laboratory is reviewing the needs and problems associated with supply and pre-supply of a manned lunar base. One question under study is what material can be placed on the moon to help insure the Apollo mission before the first Apollo crew arrives.**

► Use of multiple exhaust nozzles spaced along the trailing edges of the rotor blades of the Westland-Fairey Rotodyne VTOL transport is being evaluated in noise suppression studies. Each blade has nine pods approximately 3 in. in diameter. Static tests indicate this approach might lower takeoff and landing noise to about 85 db. Westland also is evaluating a rotor tipjet of a new design (AW Sept. 18, p. 41) and expects to adopt the cheapest and quietest method.

► **Weather will greatly affect the timing of the first manned Mercury orbital flight if it is not made in December. Chances are 90 to 1 that it can be launched on a December day, but weather in the two abort landing areas deteriorates rapidly from late December through February, and chances drop to 30 to 1. If the launch is not made by late in the year it could be postponed until next March.**

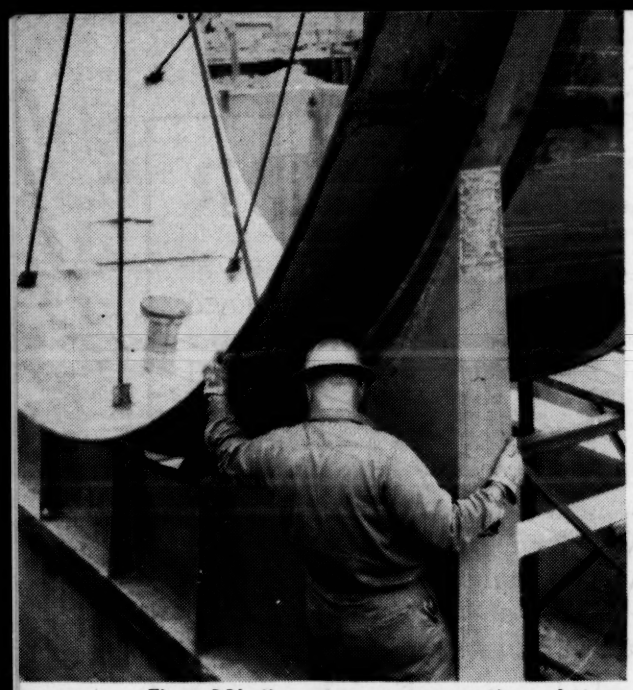
► Some 115 graduates of Air Force's test pilot school and top Strategic and Tactical Air Command pilots have been examined at USAF's Aerospace Medical Laboratory to increase knowledge of the "premium man" for space missions. Profiles of physiological characteristics and performance under stress are compiled, but studies are only to establish a framework for selection of future astronauts, not to produce a reserve supply of pilots.

► **Goodyear Aircraft and Chrysler Corp. will develop a 100-ft. dia. inflatable toroidal space station under a NASA contract. Amount of the contract is approximately $100,000. Station will be used in studies of production of artificial gravity by rotation.**

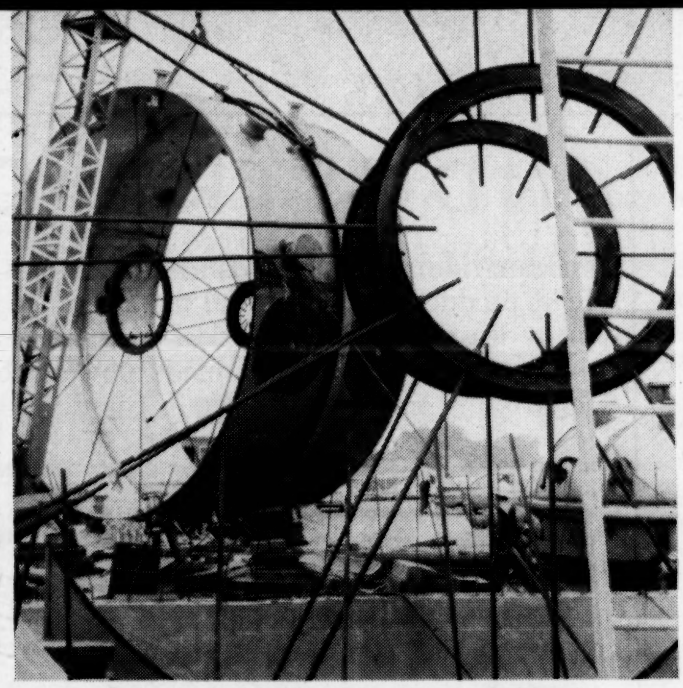
► First unmanned flight of a Lockheed QF-104 target drone is expected in mid-October at Eglin AFB, Fla. Many remotely controlled flights have been made but always with a pilot aboard as backup.

► **NASA's Space Task Group would like to acquire North American T-39 utility jets for astronauts' proficiency training and transportation. Astronauts now have access to two USAF-Convair F-106s but maintenance is a problem.**

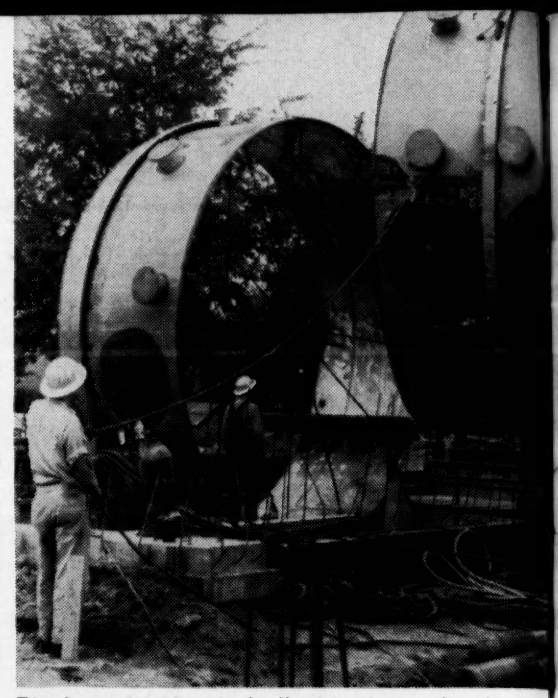
► New type of ground effect vehicle that can transport 38 passengers at a speed of about 30 mph. has been designed and successfully tested, Russians say. It is 56 ft. by 20 ft. and is built of light metals and plastics.



First 20′ diameter center section of thermal vacuum chamber settles in cradle. Chamber is fabricated from ¾" polished stainless-clad steel.

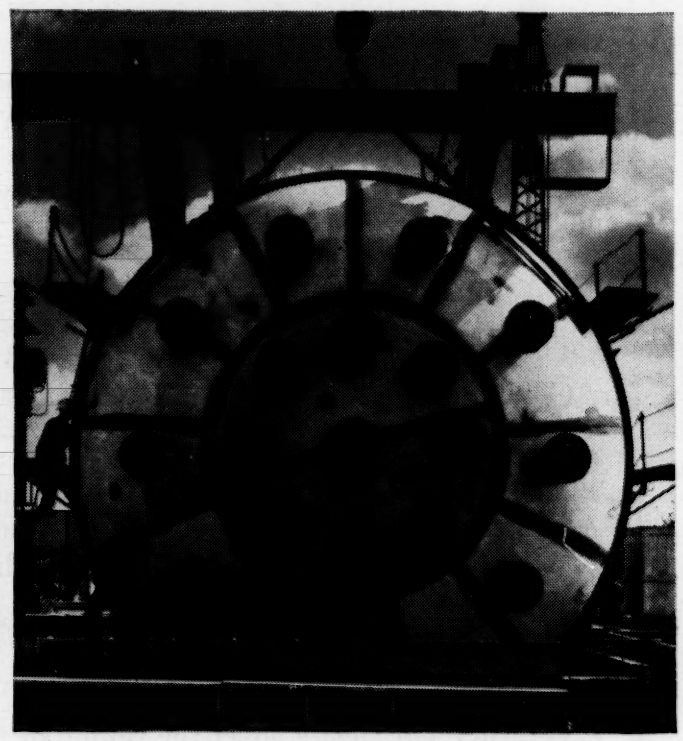


Second ring swings into place. "Spiders" inside rings ensure perfect circle mating of sections for tight weldment.

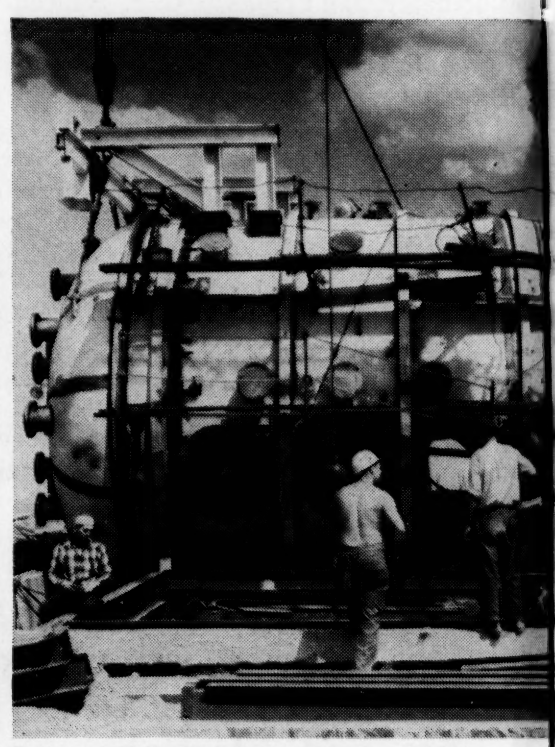


Black port cut-outs indicate where six oil diffusion pumps will attach for evacuation of chamber down to 10^{-8} mm Hg.

Full-opening head being mounted on monorail will allow internal positioning of full-size satellites and space capsules.



16 quartz lenses mounted in head will introduce solar radiation to simulate intense heat of sun in space.



Fully-erected chamber ready for addition of pumping system. With installation ahead of schedule, chamber will be operating this fall.

MAJOR EXPANSION of the Bendix Space Laboratories offers new career opportunities for engineers to develop and test tomorrow's spacecraft and space capsules. Our new facilities, such as the 20′ x 27′ thermal vacuum chamber, open key positions in management and supervision for personnel experienced in the integration, assembly, and testing of satellites. Specialists are needed for RFI, heat transfer, thermal-vacuum, vibration, structures, packaging, weight-and-balance, circuit design, and field test. Write Personnel Director, Ann Arbor, Michigan.

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Bendix Systems Division

THE Bendix CORPORATION

Washington Roundup

Dyna-Soar Review

Final decision on what to do with the Dyna-Soar boost glider project will be made after Air Force gives Defense Secretary Robert McNamara a special briefing, probably next week. He asked for a restatement of Air Force's entire case, partly as a result of his five-hour talk with Boeing officials on a visit to Seattle late last month.

Critical point is Air Force's failure so far to convince the Secretary and civilians in the Defense research and engineering office that it really needs the glider for military missions. Congress voted $185.8 million for Dyna-Soar for Fiscal 1962—$85.8 million more than the Administration asked. Nevertheless, moves now being considered include cutting the project back, possibly even to eliminate all orbital flights, and shifting it to National Aeronautics and Space Administration, which is now Dyna-Soar technical adviser.

Some civilian critics in the Pentagon feel that manned spaceflight should be handled by NASA until a military need becomes clear. They think both the X-15 and the Dyna-Soar should have been NASA projects from the outset because they see both as dead-end research projects. They also have been angered by the recent rash of Air Force and civilian statements on the military importance of space research and space weapons.

Project Highspeed

Project Highspeed, an attempt to determine whether the single-engine, single-place USAF-Convair F-106 interceptor or the twin-engine, two-place Navy-McDonnell F4H-1 interceptor is the better air superiority weapon system began last week from Langley AFB, Va., and Oceana NAS, Va. Air Force and Navy pilots are flying both types against U-2, RB-47 and drone subsonic targets and B-58 and drone supersonic targets. Outcome is expected to influence Secretary McNamara's attitude on a single air superiority fighter buy in the Fiscal 1963 budget.

Defense Department has suggested to Air Force that it look at the Navy-North American A3J for supersonic bomber missions. A3J stores weapons and fuel internally and ejects spare tanks and weapons rearward, using rocket boost.

Army Gen. Paul Adams, commander of the newly combined USAF Tactical Air Command and Army Strategic Air Command joint operational force, has recommended Maj. Gen. Bruce K. Holloway, Air Force director of operational requirements, as his deputy and Brig. Gen. Clifton Von Kann, director of Army aviation, as his operations chief. Private reaction from TAC and STRAC officers to the joint force has been surprisingly uncritical.

Soviet Visa Trouble

Soviet scientists attending the 12th International Astronautical Congress here (see p. 22) still had not received visas late last week to attend this week's Space Flight Report to the Nation in New York. It is a national meeting and State said Russia has ignored several requests for permission for U. S. scientists to attend national meetings in Russia—although both countries permit attendance at international meetings. State also indicated the exchange of scientists runs too heavily in Russia's favor. Meanwhile, Maj. Gen. Mihail Kostiuk, Russia's air attache here, can attend the New York meeting because he is a member of the sponsoring American Rocket Society.

U. S. and Russia have been invited to Geneva to help International Telecommunications Union officials develop recommendations for space communication systems before the 1963 ITU conference. Secretary-General Gerald Gross said ITU cannot now become an operating agency for communication satellites but can serve as a medium for developing agreements. He noted that the cost of establishing a communication satellite system is 10 times more than the total ITU budget since it was founded in 1876.

Aging Astronauts

All seven astronauts have had their tours of duty with NASA extended for a second three-year term, which runs into 1965, at which time they will average almost 41 years of age. There is a good chance that some, if not all, will stay with NASA for the Apollo program, but because of age they may advise rather than fly.

E. M. Cortright, now assistant director of space flight programs for lunar and planetary programs and acting assistant director of program planning and coordination in the space flight office, will be named as Dr. Homer E. Newell, Jr.'s deputy in the new space sciences office.

Decision is imminent on whether to proceed with development of USAF's Pluto nuclear ramjet. An ad hoc committee named by Defense Research Director Dr. Harold Brown is completing its report. USAF has asked for $71 million in the next two fiscal years.

Mariner payloads that will be reduced in weight and shifted from the Atlas-Centaur to the Atlas-Agena B booster (AW Oct. 2, p. 26) have been designated Mariner R, with R standing for Ranger. Jet Propulsion Laboratory's unofficial name for them is Manger—contraction of Mariner and Ranger. **—Washington Staff**

Soviets, U.S. Call for Space Cooperation

12th International Astronautical Congress is told that Russia might someday launch joint payloads.

Washington—U. S. and Soviet Russia swapped pleas for worldwide cooperation in space at the 12th annual International Astronautical Congress last week, with both sides indicating that joint U. S.-USSR space projects might have been under way long ago if the decisions had been left to scientists rather than governments.

At an unscheduled question and answer session during the opening ceremony, National Aeronautics and Space Administration's Deputy Administrator Hugh L. Dryden said he and Russia's Leonid I. Sedov had discussed "many times" the possibility of sending U. S. instruments into orbit aboard a Soviet satellite, "and I expect if it were up to us, there would be no problem."

Sedov, the outgoing president of the International Astronautical Federation and head of the Soviet Academy of Sciences' space flight group, said he thought it would be possible in the future for Russia to cooperate in launchings not only with the U. S. but with other countries.

The U. S. has developed an extensive cooperative program with other nations (see p. 27). Russia's cooperative efforts have been limited to tracking and instrumentation agreements with other Communist nations.

At last year's IAF Congress in Stockholm, Russia injected political issues by insisting that the revised IAF constitution guarantee Russia and the U. S. top offices each year and give the two countries veto power over items they wished to exclude from the discussion agenda. Since then, however, Russia has agreed to drop both proposals and the 12th congress adopted a constitution that did not include them.

Dryden reminded the delegates that 65 earth satellites and four solar satellites, weighing a total of 75 tons, have been launched in the four years since Sputnik I. In contrast to previous Soviet remarks which deprecated the sub-orbital flights of U. S. astronauts, Sedov included Cmdr. Alan Shepard and Capt. Virgil Grissom with Russia's Maj. Yuri Gagarin and Maj. Gherman Titov in citing the manned flights that have been made since the last congress.

Sedov also predicted that new space projects are under way which "will again astound the world in the near future." Soviet space launchings have coincided with IAF congresses in 1957, 1959 and 1960.

Three new astronautical societies—from Cyprus, Mexico and Romania—were admitted to membership in the IAF, to raise the total number of member societies to 44. Registration at the congress had topped 570 by the middle of last week, and was expected to increase substantially later in the week.

Two-thirds of the speakers or papers programed for the congress came from the U. S., reflecting a major reality and one of the major complaints about these international technical meetings. Of the remaining third of 174 presentations listed, 13 were from Great Britain and nine from Russia. France contributed seven and Germany and Italy gave four each.

These statistics do not reflect the degree of international participation precisely, because of the many unlisted contributions that are made in discussion sessions. But they do illustrate the fact that the major source of published data on astronautics originates in the U. S. They further underline the complaints voiced privately by some representatives of member societies, who fear that the IAF is already too strongly dominated by a handful of people from a small number of societies.

The nine Russian contributions were heavily on the side of space science, covering with equal emphasis some three-year old data from Sputnik III and some recent preliminary results from Maj. Gherman Titov's orbital flight.

O. G. Gazenko and V. I. Yazdovsky of the USSR Academy of Sciences reported that Titov suffered discomfort resembling seasickness during the major portion of his flight. This sensation was due to vestibular disturbances which were felt more strongly when Titov moved his head or tried to observe moving objects. The disturbances decreased somewhat after he slept, but did not disappear.

Yazdovsky said Titov's observations of this discomfort ". . . require careful analysis and undoubtedly will serve as an initial point for special investigations in this direction."

Variations in heart action, first discovered by the Russians during orbital experiments with animals, showed up to a similar degree in the electrocardiogram (EKG) taken on Maj. Yuri Gagarin when he made the first single-orbit flight by man around the earth last April. During the first four to six hours of orbital flight, the frequency fluctuation of animal heart beat went through considerable and diverging variations. Relative instability of the heartbeat rhythm was present throughout the period of weightlessness. Respira-

Soviet Delegation to IAF

Washington—Soviet Russia's delegation to the 12th annual International Astronautical Congress was headed as usual by Academician Leonid I. Sedov, who is head of the USSR Academy of Sciences' Interplanetary Communications Commission and has just completed his second term as IAF president. It included these specialists:

- **K. I. Gringauz, doctor of technical science and member of the Radiotechnical Institute of the USSR Academy of Sciences. Gringauz presented a paper on investigations of interplanetary plasma and planetary ionospheres by means of charged particle traps on rockets. His general field of work is electronics.**
- **Vladimir A. Kotelnikov, doctor of technical science and active member of the Academy, who presented a paper on radar contact with Venus. His field is radio engineering.**
- **Valeryan I. Krassovsky, doctor of physico-mathematical science and member of the Institute for Physics of the Atmosphere of the Academy. Krassovsky, whose fields are astronomy and astrophysics, gave a paper on the hardest solar corpuscles.**
- **Lev G. Loytsyansky, doctor of technical science and head of the aerodynamics department of Leningrad Polytechnic Institute. His specialty is fluid mechanics.**
- **Madame T. N. Nazarova, whose field is meteoritics. She presented a report on investigations of meteoric dust by means of rockets and satellite vehicles.**
- **Vladimir I. Yazdovsky, colonel in the Russian Army Medical Service and an associate of the Academy of Medical Sciences of the USSR. Col Yazdovsky, whose specialty is aerospace medicine, presented a paper written jointly with Lt. Col. Oleg G. Gazenko on some of the physiological results of space flight.**
- **Vladlen S. Vereshchetin, whose field is law, languages and interpretation, and who has been identified with the presidium of the Academy of Sciences. He attended last year's meeting in Stockholm as the delegation's interpreter.**
- **Nikolai Khabarin of the Academy of Sciences, whose field is translation and interpretation.**

tion depth and frequency was also noticeably non-uniform, according to the Russian authors.

Gagarin's EKG showed the rhythm fluctuations experienced with the animals, but to a lesser degree.

Exploration of the ionosphere of planets was suggested by K. I. Gringauz, also of the Soviet Academy of Sciences, as a necessary prelude to manned landings. He pointed out that this knowledge would be essential to guarantee reliable radio communication between any manned landing party and the earth.

Gringauz said two approaches were possible. The first would be an impulse ionospheric station, carried to a close orbit of the planet being studied and transmitting its findings to earth by telemetry. The difficulty with this technique is that the station must have a very wide band range of detection equipment because the critical frequencies of the planetary atmosphere would be unknown. This in turn would mean high weight of the station.

The alternate method would be to probe the ionosphere by impacting a sounding rocket on the planet. The quantity of data returned would necessarily be considerably less, but of enough value to justify the experiments. Gringauz said that charged-particle traps of the type used on Sputnik III would be a most useful means for ionospheric exploration by rockets.

Growing capability and interest of European nations in space flight was underscored by a number of papers describing progress in solving specific problems, rather than the nebulous generalized studies that characterized European contributions at many earlier congresses.

Outstanding example of this was a detailed analysis and design study of a liquid oxygen-liquid hydrogen third stage powerplant for the proposed Blue Streak-Veronique European space vehicle. The proposal was presented by A. W. T. Mottram, chief research engineer for the rocket division of Bristol Siddeley Engines Ltd., of Coventry.

Mottram described a pair of engines –booster and vernier–designed to match the characteristics of a third stage that would in turn match the British Blue Streak first stage and French Veronique second stage. The over-all vehicle, weighing 7,000 lb. and measuring 6 ft. in diameter by 15 ft., 9 in. long, would carry a payload of 1,015 lb. with an orbital weight of 2,020 lb.

Thrust chambers would produce 3,500 lb. each, and the vernier engines would be rated at 45 lb. thrust each. Both types of engines would be used in pairs, so that the total booster thrust available would be 7,000 lb., and vernier thrust would total 90 lb.

Specific impulse of the booster engine would be 410 sec., and the expansion ratio would be approximately 2,500.

Inter-orbital transfer from a 300-mi. circular orbit to a 24-hr. synchronous orbit was studied by P. A. E. Stewart and J. F. Swale, of the Astronautical Group of Hawker Siddeley Aviation Ltd., as part of that company's work on communications satellites.

Starting with a 9,000-lb. vehicle in the 300-mi. orbit–the capability of the Atlas-Centaur vehicle – the authors studied the design of 10 different propulsion systems to do the job. This corresponds roughly to the vehicle and mission planned for orbiting of U. S. Army's Advent satellite (AW Oct. 2, p. 26).

- **Solar thermodynamic,** in which a solar collector is used to operate a solar boiler to heat hydrogen for propulsion.
- **Open cycle nuclear thermodynamic,** which would use liquid hydrogen heated by a nuclear reactor.
- **Closed cycle nuclear-electrothermal** (arc jet), using a Snap 8 power supply with helium as the propellant.
- **Closed cycle nuclear-electrothermal** (Bostick motor), in which deuterium-loaded titanium wire is the propellant, and is vaporized and accelerated by an electric arc.
- **Closed cycle nuclear-electrostatic** (ion), with cesium propellant pumped through a sintered tungsten emitter and accelerated by an electrode which would have a 1,650-volt potential.
- **Closed cycle nuclear-electromagnetic** (exploding wire), in which wire propellant is vaporized by a high, short-duration current discharged from a 450-joule capacitor.
- **Chemical solid,** with a conventional two-stage vehicle using JPN Ballistite as propellant.
- **Chemical liquid monopropellant** using the decomposition of hydrazine to produce thrust.
- **Chemical liquid bipropellant,** using mixed amine fuel and red fuming nitric acid as the oxidizer in a conventional chemical liquid-propellant rocket.
- **Chemical liquid bipropellant,** using liquid oxygen and hydrogen in the conventional manner to generate thrust.

The authors calculated a series of figures of merit for the specific mission for each type of propulsion system. These figures included factors for ease of control, payload, complexity, state of development, time for transfer and cost, which were combined in a simple formula to arrive at an over-all figure of merit to choose the best system.

On this basis, and for this mission only, the solar thermodynamic system was the best choice by a wide margin, with the chemical liquid monopropellant system running second and the open-cycle nuclear thermodynamic engine right behind it.

U. S., Russian Venus Measurements

Washington–U. S. and Russian determinations of the magnitude of the astronomical unit–mean distance from the sun to earth–are now in extremely close agreement.

Dr. Vladimir A. Kotelnikov, member of the USSR Academy of Sciences, told the 12th International Astronautical Congress that Russian radar returns from the planet Venus indicate a value of 149,599,500 km. for the astronomical unit. This is a major revision of the value of 149,469,500 km. first released by the Russians earlier this year.

The Russian value compares with 149,598,820 km. obtained by Jet Propulsion Laboratory using the Goldstone radar, and with a figure of 149,597,850 km. obtained by Lincoln Laboratory with its Millstone Hill radar. Total spread between maximum and minimum values is now about 0.001%. Value of the astronomical unit may be more familiarly recognized as approximately 93 million miles.

But sharp disagreement remains on whether Venus rotates about its own axis with a 9- to 11-day period, or only once during each 225-day orbit around the sun.

The hypothesis that Venus rotates with the 9- to 11-day period is based on an apparent doppler frequency shift, corresponding to a planet velocity of 40 meters per second, in echos received from Venus, Kotelnikov said. But Dr. Gordon H. Pettengill of Lincoln Laboratory said that its radar contacts with Venus in many repeated experiments had failed to show any such doppler shift. Analysis of tape recordings made during a previous Venus radar contact in 1959 also failed to disclose any such doppler shift. Data presented by a JPL representative closely supported the figures cited by Pettengill.

The fact that the U. S. experiments were conducted using two different radars, operating at different frequencies, one pulse type and the other continuous-wave, with such close correlation of the results tended to support the validity of the anti-rotation view. The Lincoln Laboratory radar, using pulsed transmissions, operated at 440 mc.; the JPL radar, a continuous-wave equipment, operated at 2,388 mc.

The radar used in the Soviet experiments operated at 700 mc., with a power flux density of 250 megawatts per steradian, providing 15 watts on the surface of Venus, Dr. Kotelnikov said. Transmitted signal consisted of square pulse of 128 milliseconds duration, followed by space of similar duration or by a pulse of 64 milliseconds.

Defense Plans to Spend $6.5 Billion Through 1970 for Tactical Fighter

Washington—Program package of $6.5 billion that extends through 1970 has been scheduled by the Department of Defense for the TFX tactical fighter.

Requests for proposals, sent to airframe companies Sept. 29, are worded in such a way that differing Air Force and Navy requirements would be met by using a single basic airframe but taking divergent approaches for armament, fire control and fuel capacity. Proposals are due at the Air Force Aeronautical Systems Division on Dec. 6.

A four-man board will review the proposals. The non-voting chairman will be Maj. Gen. W. Austin Davis, ASD commander. The Navy member will be Rear Adm. Frederick L. Ashworth, assistant chief of the Bureau of Naval Weapons for research, development, test and evaluation. No determination had been made late last week as to who the other two Air Force members would be. One member will be from the Tactical Air Command and the other either from the Systems Command or the Logistics Command.

The specifications call for a twin-engine aircraft. Weights and performance specifications are such that the Pratt & Whitney turbofan TF-30 (JTF10A) is the only engine that currently qualifies. Its original thrust rating of 8,250 lb. has already been boosted to over 10,000 lb. and it has a growth potential beyond that.

Air Force requirements include a capability for transoceanic nonrefueled flight for ferry purposes. To achieve a greater fuel load it wants a less complex fire control system for air-to-air missiles, probably an improved Sidewinder equipped with nuclear or conventional high explosive warheads. Air Force also wants the capability of high supersonic dash for 200 miles at Mach 2.2.

Navy does not desire the long ferry range and wants a more sophisticated missile system. The long-range Eagle missile was far enough along when development was halted that its first stage could be strengthened and the second stage eliminated. It would use the same guidance system originally designed for Eagle.

Air Force allows only 2,000 lb. of the 60,000 lb. gross weight of its version for armament. Navy allows 6,000 lb. of its 55,000 lb. gross weight. Both services have agreed on the variable geometry wing concept.

The final position of the Air Force before a two-service compromise was reached recently (AW Sept. 11, p. 30) was for a 73-ft.-long airplane weighing 60,000 lb., considerably smaller than the original position of 85 to 90 ft. and 90,000 to 95,000 lb. The Navy position was for a 56-ft. length and 55,000 lb. The Navy is willing to concede on the length but has set the 55,000 lb. limit as its refusal point. If this is exceeded, Navy may withdraw from the program.

Republic Aviation Corp., Boeing Co., North American Aviation, Inc. and Lockheed Aircraft Corp. have spent company funds in developing the TFX design.

In a related field, the Fiscal 1963 budget will contain an interim buy of 400 Douglas A4D-5 single-place, single-engine attack aircraft for use by Air Force's Tactical Air Command. Earlier versions of the aircraft are currently operational in the Navy and Marine Corps. Although the language of a Defense Department directive sent to the Air Force recently said Air Force must buy "A4D or similar aircraft," for its interim close-support attack aircraft, it is indicated that the intent is that the service must buy a relatively unsophisticated aircraft that can perform close support. This eliminates higher priced vehicles such as the Republic F-105 for this particular mission.

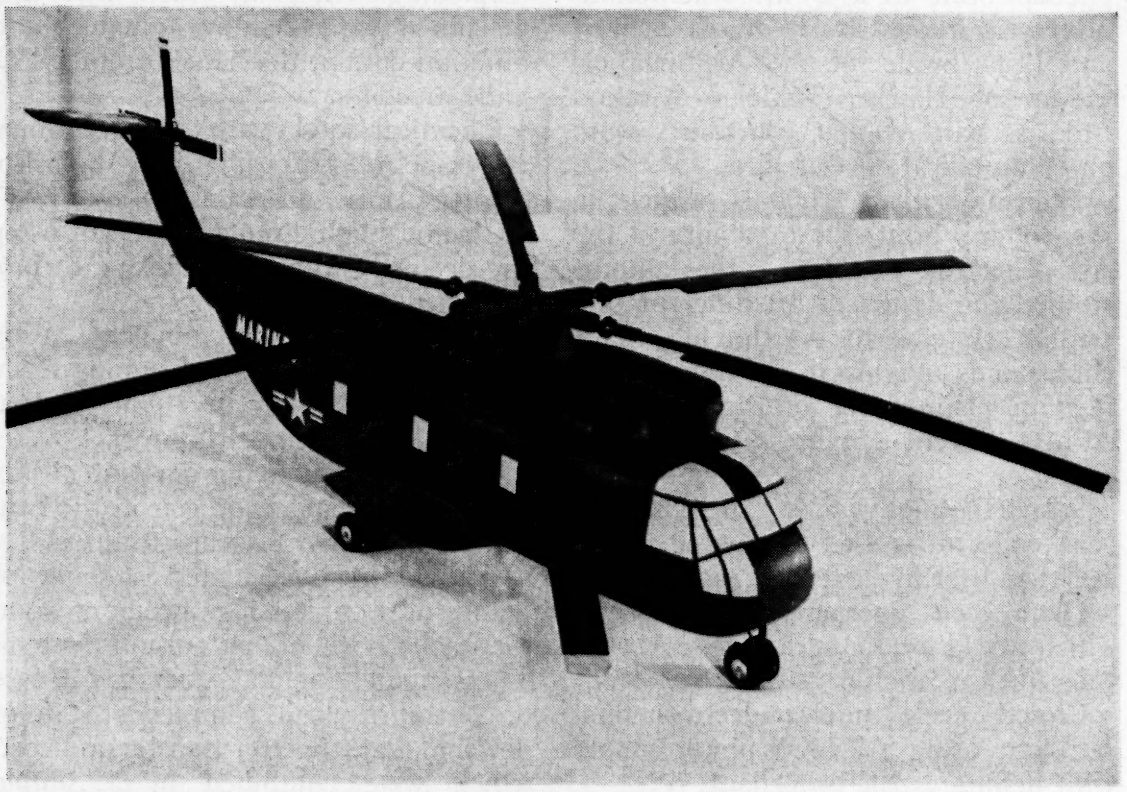
The total program for close support aircraft is 1,500 aircraft by 1968. Of this total, 400 will be the A4D mentioned above and the remainder will be the VAX close-support fighter, which is yet to be developed.

Houston Site Criticized

Washington—A Boston official, previewing criticism National Aeronautics and Space Administration can expect to receive with increasing frequency as the space program expands, last week said the agency "probably put the whole space program back several years and increased the cost of it" by selecting Houston, Tex., for its manned space flight center.

Ephron Catlin, president of the Greater Boston Chamber of Commerce, said Boston's cultural advantages keep many Harvard University and Massachusetts Institute of Technology graduates in the city as permanent residents. "I don't think Houston with its Jim Crow civilization is going to be able to draw them," he said. The Jim Crow practices also would increase the cost of the space program, he said.

Boston was one of many locations that hoped to obtain the space center. Catlin said city leaders did not organize as soon as their Texas rivals, and added that Texas congressmen were "very powerful and astute."

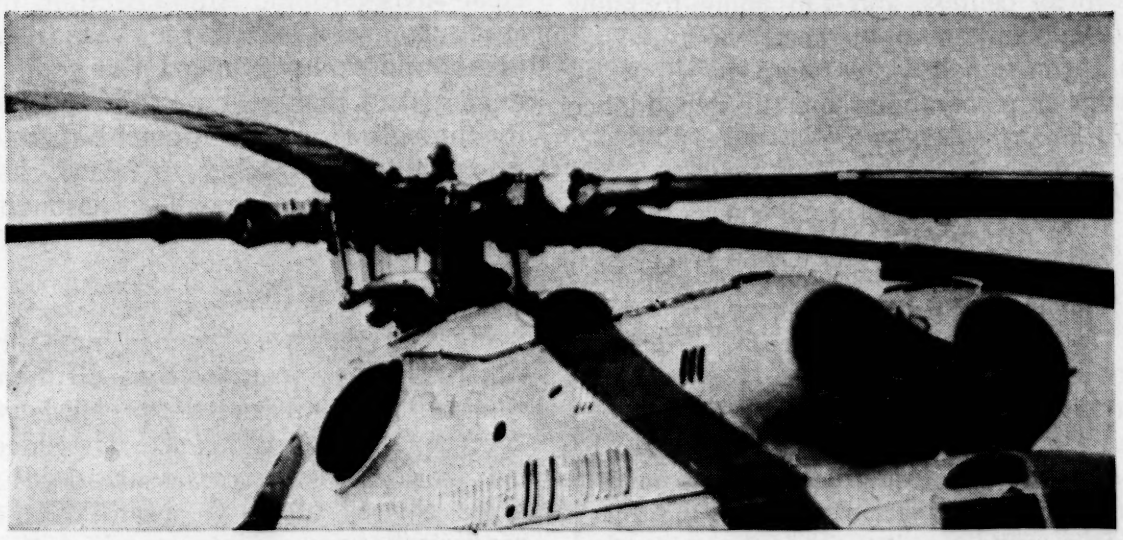


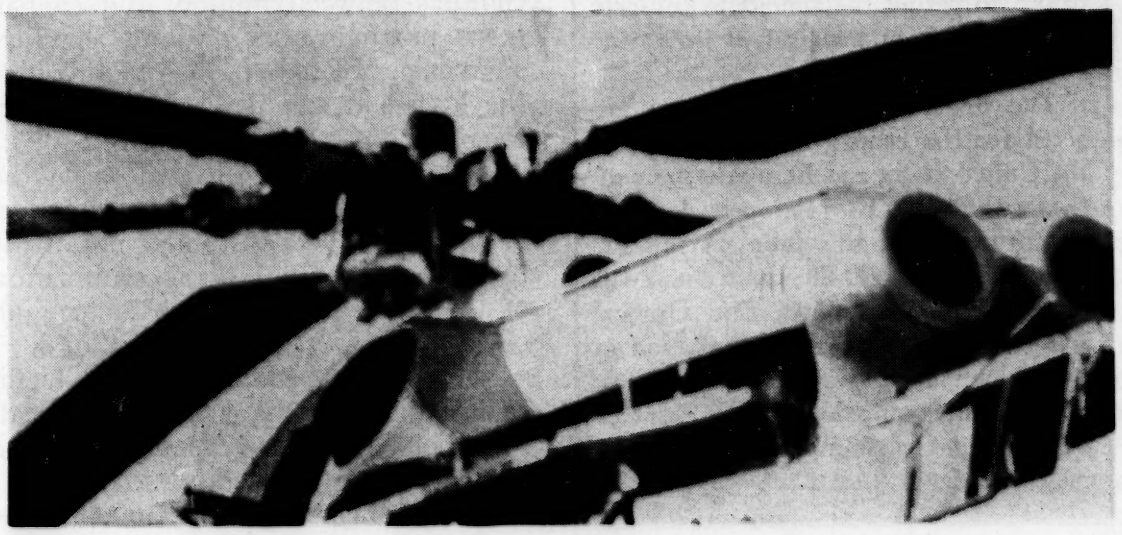
Sikorsky Designs Assault Transport Helicopter

Sikorsky has proposed a new heavy assault transport helicopter, shown here in model form, to the military. The helicopter, which may be aimed at a Marine Corps requirement, uses the S-64 rotor system with a new fuselage. The new helicopter would have a four-ton capacity, which would increase to nine tons for short-range flights. Other features include watertight floating hull, rear loading with a hydraulically operated ramp, retractable tricycle gear, carrier operations compatibility, automatic blade and tail folding systems and all-weather operation ability. Sikorsky recently has been briefing airlines on its S-65 concept, which also uses the S-64 rotor system with a new fuselage (AW Oct. 2, p. 47).

Photos Reveal Soviet Mil Crane Design Details

Forward landing gear arrangement of the Soviet Mil flying crane with which the Russians broke lifting records for helicopters (AW Oct. 2, p. 33) shows differences from the crane first shown at the Tushino air show (AW July 17, p. 33). Fairing has been added to the inboard V-tubing section, and the width of the V appears to have been reduced. Small diameter tubing extending from cockpit may be torque bracing for the gear. Cockpit appears to have bay between the pilot and copilot seats permitting access to the cargo handler's cylindrical compartment on the belly. Side windows on cockpit are bubble shaped to permit observation below and behind. Close-up of rotor hubs of the crane (bottom) and the Mi-6 (center), which set a speed record at the same time, show differences. Crane hub is larger, and blades do not have the long sleeve section at the root; those of the Mi-6 do. Mi-6 blades are straight, but blades of the crane appear to taper.





Vice President Begins Nationwide Tour of Major Space Installations

By Edward H. Kolcum

Los Angeles—President Kennedy has decided to support the space program on a personal basis through Vice President Lyndon Johnson, who last week began a tour of space installations that eventually will include all major civilian, military and possibly industrial facilities in the country.

The Vice President made it clear that the Kennedy Administration considers space one of the most critical aspects of U. S. foreign and domestic programs, and his visits to space installations are designed to demonstrate this backing.

Johnson, who also is chairman of the National Aeronautics and Space Council, last week toured National Aeronautics and Space Administration facilities at Ames Research Center, Edwards flight and rocket test centers, Jet Propulsion Laboratory and Vandenberg AFB, all in California. He also toured the Air Force School of Aerospace Medicine at Brooks AFB, Tex., and announced plans to visit NASA's Saturn assembly plant at Michoud, La., and the Atlantic Missile Range in Florida in two weeks.

Johnson said he expects to continue the personal visits to Air Force facilities and some industrial plants. "I am going to all centers, and I'm going to know the people in all of them," he said.

Johnson took extreme pains at all his stops to underscore the dependence of the space program on field installations. In Washington, he said, "we can make policy but we can't make boosters."

The Vice President began his tour shortly after returning from Stockholm as the U. S. representative at the funeral of United Nations Secretary General Dag Hammarskjold, and he said that just as the people in the North American Treaty Organization will be ready to put everything they have into a joint effort if war begins, "we want to put everything we can into the space effort . . . but why the hell do we have to wait for the bomb to drop?"

After his initial visits, Johnson said that most of the major space ills have been cured by added appropriations, which have succeeded in accelerating the over-all program by several months. He learned early in the tour, however, that NASA cannot compete with industry in salaries. Several top Ames research scientists have left the government within the past two weeks.

The Vice President obviously wants to instill a feeling of enthusiasm in government work, because he told the top officials at Ames that "President Kennedy is counting on you, and betting on you."

The space council apparently is growing rapidly in importance as the principal adviser to the Administration on space policy. One of the Vice President's aides characterized the council as an agency that is gaining the capability through a small, competent staff to recommend approaches to space that will fit into the over-all government program.

Aware of Conflicts

He said the space council probably will never grow to more than 20 men, who will be a mixture of specialists in government, law and science. He added that both the Vice President and the space council are fully aware of the conflicts between military and civilian space programs, but said the conflicts are being isolated to the point where the President can make a decision on them.

The aide said NASA will have the major space role, and the Defense Department will be a customer—not of the civilian agency, but of a combination of civilian and industrial space technology.

The Vice President's visits to facilities are designed to give him a broad-brush look at existing capabilities in the U. S. First leg of the trip covered:

• **Ames,** which included demonstration of pilot simulation of the Apollo spacecraft; problem areas in supersonic transport landing; demonstration flights of a C-130 with boundary layer control, and an X-14 with variable stability; stability and performance during re-entry from an escape mission, and solar research.

Dr. Smith J. DeFrance, Ames director, said this was the first time in his more than 40 years as a government scientist that he has been visited by a ranking Administration leader. Rep. George Miller (D.-Calif.), chairman of the House Committee on Science and Astronautics, joined the Johnson party during the Ames tour.

• **Edwards,** which included discussion on the X-15 project and newly announced X-15 objectives during the next two to three years. These are demonstration of spacecraft flight control systems, structures research, celestial photography unhampered by the earth's atmosphere, and demonstration flights of satellite research instruments.

Abort Technique

Technique to be used for an abort in the launch phase of a Dyna-Soar boost glider flight was demonstrated with an F5D, in which the pilot goes into a maneuver similar to a low-altitude bombing system (LABS) maneuver to bring the vehicle to a landing strip.

Demonstration firing of a Rocketdyne 1.5-million-lb. thrust F-1 engine did not take place because of a faulty ignition signal.

• **Jet Propulsion Laboratory,** including briefings on lunar and planetary programs, a demonstration of Ranger 3, the lunar rough landing vehicle, and a seismometer on this vehicle. Mockups were shown of the lunar soft landing Surveyor as well as the Mariner spacecraft.

• **Vandenberg** facilities used by NASA, which include the Thor Agena B complex 75-1; the biological Bios probe area; Pacific Missile Range Scout pad, now under construction; Mercury command station and Tiros data acquisition station.

B-101C Design Changes

Present configuration of Israel Aircraft Industries' B-101C jet executive transport will undergo extensive redesign, according to IAI sources. The twin-jet, six-to-nine place transport, a mockup of which was displayed at IAI's Lod, Israel facility (AW Apr. 10, p. 108), is undergoing the changes, according to the company, "to permit the aircraft to compete better in the world market by improving its range and speed."

The Israeli-designed airplane was targeted for the executive market both in the United States and Europe. Competitive with it are two European-designed aircraft aimed at the same market—the Douglas-Piaggio PD-808 and the Swiss American Aviation SAAC 23. Original IAI plans had called for construction of two flying prototypes and a static test model upon completion of a world survey to determine sales prospects for the Israeli aircraft.

NASA Lauded for Aid To Small Contractors

Washington—National Aeronautics and Space Administration "is doing an outstanding job to assist small businesses in obtaining their fair share of the research and development dollar," according to a House Science and Astronautics Committee report.

The 15-page report said NASA estimated 16% of its research money is going to small businesses. To ensure that this trend continues, the report recommended that projects be broken down into "small packages" whenever possible.

Booster for British Satellite Is Switched

Washington—Britain's International Satellite No. 1 has become too large and heavy to be launched by National Aeronautics and Space Administration's Scout launch vehicle and will have to be launched by the NASA Delta.

The four-stage, solid-propellant Scout can lift 150 lb. into a 300-mi. earth orbit. The British satellite, also known as U.K.-1, weighs 128 lb. but is to be put into an orbit with a 200-mi. perigee and 600-mi. apogee. The larger Delta vehicle, which uses a Douglas Thor as the first state, can lift 500 lb. into a 300-mi. orbit.

The change in plans was made Sept. 8 and announced last week to foreign newsmen attending the 12th annual International Astronautical Congress here by Arnold W. Frutkin, director of international programs for NASA. The change also means a shift in launch site from Wallops Island, Va., to Cape Canaveral, Fla.

Frutkin pointed out that NASA's international program is the only substantial cooperative space program, and said it consists of these phases:

• **Participation** on an international level in weather and communications satellite programs. Twenty-six nations, including Czechoslovakia and Poland, have accepted invitations to an international meteorological workshop to be held here next month. Britain, France, Germany and at least one South American country will build terminal stations for the communications satellite program.

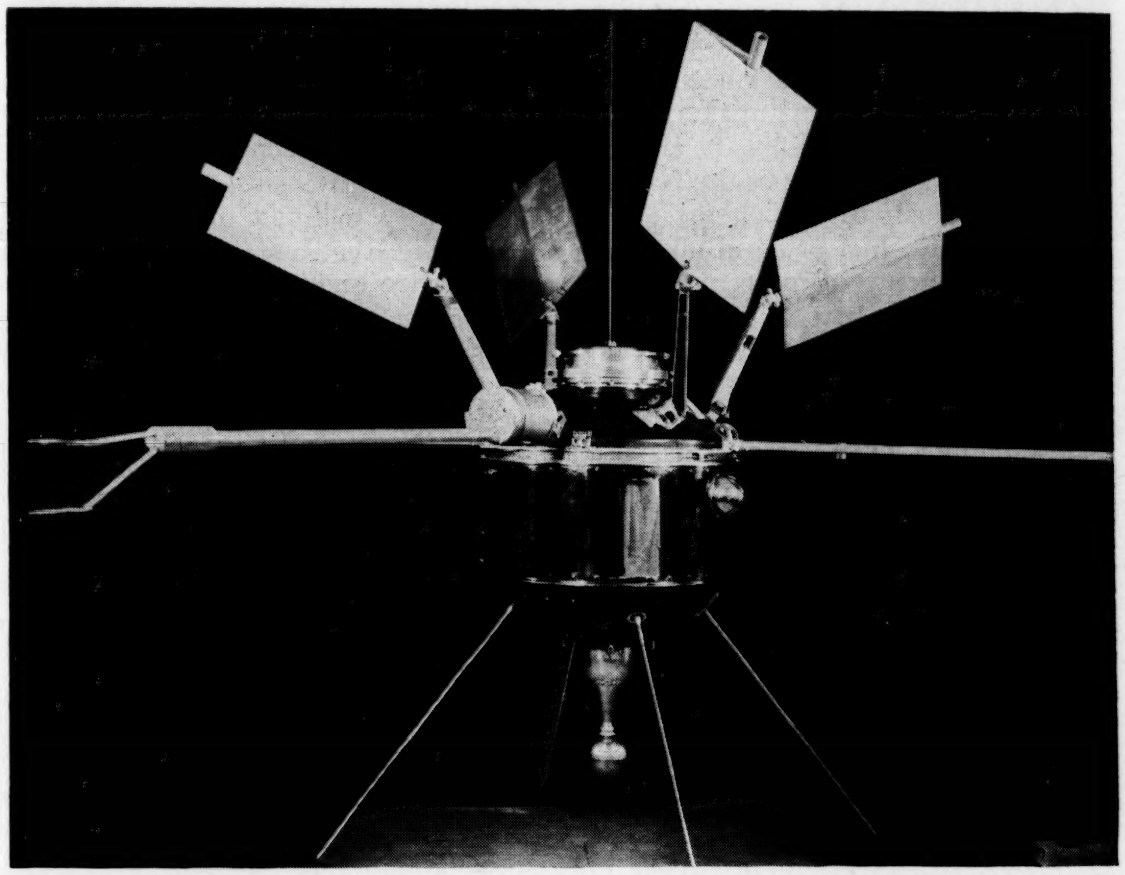
• **Sounding rocket** agreements between the U. S. and Argentina, Pakistan, Norway and Denmark jointly, Italy, Canada, Australia, France and Sweden. Negotiations are being completed with Japan, calling for the launch of two Nike-Cajun rockets, each containing U. S. and Japanese instruments. Radio Research Laboratories is sponsoring the Japanese effort.

Although most involve U. S. rockets, a British Skylark rocket was launched last September by an Australian crew from the Woomera Range, carrying U. S. instruments designed to measure southern sky ultraviolet radiation.

• **Training programs,** in which senior associateships are sponsored by NASA through the National Academy of Sciences; technicians trained in U. S. research centers and laboratories; and graduate training for foreign students. Twenty-six senior associates are under training in U. S. universities, and plans are being made to sponsor as many as 100 foreign graduate students during the 1962 school year. NASA will pay tuition, while the sponsoring nations will pay passage and stipends.

Frutkin said approximately 40 nations are involved in NASA's international programs, including 20 in operation of U. S. tracking stations, and Britain and Canada in satellite programs.

He said NASA is extremely flexible in agreements with other countries. The agency has an understanding with the U. S. State Department allowing technical discussions before diplomatic discussions are begun. Once the technical basis has been established, he said, an understanding can be made. The British satellite program is the result of a formal bilateral; the Canadian satellite program came as the result of an exchange of letters.



JOINT U. S.-BRITISH international ionosphere satellite, designated UK-1, is tested for moment of inertia characteristics around the spin axis at National Aeronautics and Space Administration's Goddard Space Flight Center. The satellite, weighing 128 lb., will be launched from the Atlantic Missile Range early next year with a Delta vehicle into a 200-600 mi. orbit. Payload instruments were developed by several British universities, and Goddard integrated them into the NASA-built satellite structure.

European Space Club Snag

London—Three nations once interested in joining a 12-nation European space program—Switzerland, Austria and Norway—may drop out of the project, which is based on the use of the de Havilland Blue Streak as a prime launcher.

The three countries have declined invitations to meet here later this month in a special convention to plan the joint project, although invitations from British and French governments have been accepted by Germany, Denmark, Belgium, The Netherlands and Spain. No replies had been received last week from Italy and Sweden.

No date has been set for the convention, although preliminary details were set by a special British ministerial meeting last week. Minister of Aviation Peter Thorneycroft, who has spearheaded the formation of a European space club, was chairman.

Huge Waste Reported In Electronic Projects

Washington—Poor management of Federal electronic research programs costs the taxpayers about $200 million yearly in unnecessary projects, according to a Senate Government Operations Reorganization Subcommittee report.

Chairman Hubert H. Humphrey (D.-Minn.) said the reason for the waste is such "poor management of information on tens of thousands of current projects" that research contracts by the Defense Department and National Aeronautics and Space Administration often duplicate work done or in progress.

The subcommittee recommended better coordination of information on the projects, suggesting a central index. Sen. Humphrey said under present conditions "programs crucial to the nation's security do not attain their highest and promptest yield."

Hayward Scores Glossy R&D Proposals

New York—U. S. weapon systems research and development competition too often turns into a game of who can exaggerate the most in the glossiest proposal, Vice Adm. John T. Hayward told the annual meeting of the National Security Industrial Assn. here.

The deputy chief of naval operations for development, blaming neither industry nor the Pentagon exclusively for this state of affairs, said that the ultimate effect has been an increase in lead times and the loss of ability to deliver hardware in a hurry. It also has been a factor in swelling the lists of what Adm. Hayward called the "Turkey Row" of programs that failed.

Preliminary Design

"Unfortunately, much of the competition between companies engaged in research and development is now concentrated at the stage of preliminary design," Adm. Hayward said. "It is common practice for the military to invite industry to submit proposals for a new weapon system. As a result, there is intense competition among the companies—feet on feet of papers—to produce a glamorous and exotic proposal. But too often this type of competition is in optimism and exaggeration. The one who exaggerates the most, wins, in costs as well as technical features.

"There is abundant evidence that no one—administrator or scientist—is good at picking winners at this stage.

"However, judging the performance of actual hardware—even test models—is relatively easy and reliable. Exaggerated claims are easily debunked on the test stand."

Prototypes are better competitors than paper proposals, Adm. Hayward said, and research and development needs more of this kind of competition, more of what might be termed by some duplication and "confusion" in an area that consists mostly of uncertainties.

One thing that the pictures of the Tushino air show (AW July 17, p. 26; July 24, p. 26) demonstrated, he said, is that the Russians clearly still have the ability to build prototypes.

Taking the case of the TFX, the Tri-Service Fighter, Adm. Hayward said he believed it would be cheaper in the long run for the government to finance one prototype to be built by each competitor than to pick the best airplane from the batch of proposals that will be submitted. "I wonder," he said, "how much money will be spent on those?"

Components are a particularly critical area, he said, and especially require "duplication."

"The TFX won't be operational until 1968," he said. "It galls me that it will take so long. Where are the TFX engines? We're just starting on the TF30. By buying more hardware in the development stage, getting more duplication, we could cut lead time.

"In lots of systems in the last 16 years we had to invent on schedule. Some are still not systems today."

Lessons can be learned from near-at-hand history, Adm. Hayward said—for one, the Martin P6M SeaMaster turbojet-powered seaplane which he described as a member of the Navy's "Turkey Row."

Technical Homework

"We hadn't done our technical homework," he said. "We went to a long, high fineness ratio hull without enough consideration of the structural and vibration problems entailed. We went from a paper concept to an advanced airplane."

Navy and Martin, he said, contributed to the problems that led to the cancellation of the program in 1959.

Industry itself has been bitterly critical of proposal battles, especially companies that have invested a quarter or half million dollars in a proposal that lost out in the competition. Adm. Hayward agreed this viewpoint existed in industry, but he noted that too often the first reaction to a development program in industry was, "How many shall I tool up for?"

Numerous Problems

Shifting gears to an industry better able to produce prototypes quickly involves many problems, many of them political ones, which Adm. Hayward said he was in no position to discuss. Some aids to solutions he noted included the following:

- **Slimming oversize engineering** staffs, which often are a product of military preoccupation in the past with numbers rather than quality.
- **Sharing of production** among competitors to keep industrial organizations intact.
- **Providing more incentive** in research and development work. "A fundamental problem in the U. S.," he said, "is the way the laws are written. They're based on the assumption that we [the military] are dishonest, that industry is dishonest."

Duplication may be an evil word in budgeting, but it often can save money—for example, the ascending costs when a program is stretched out because of a delay in development of a critical component, he said.

"A general rule in planning," Adm. Hayward said, "would be that the greater the uncertainty, the more necessity for duplication to accomplish the task. In recent years, the centripetal force centralizing all research and development has brought about a lack of

First Grumman A2F to A2F Inflight Refueling Demonstrated

First demonstration of A2F to A2F refueling was recently conducted at Grumman Aircraft's Bethpage facility. Tanker ship (left) carries four 300-gal. underwing tanks. Belly pod accommodates standard Douglas buddy tank which underwent minor modifications to equip it for use on the Intruder. There are seven A2Fs built and flying. Program has entered the avionics qualifications flight phase.

Lead-Time Speedup Plan

Navy is experimenting with accelerating the development cycle in selected programs, hoping to cut lead times as much as two years, according to Vice Adm. John T. Hayward, deputy chief of naval operations for development.

One program is the Gilfillan SPS-48 very large, long-range shipboard radar system, which has a Marine Corps land-based counterpart, the TPS-32. A second program probably will be the Texas Instruments' anti-radar missile, and a third probably an anti-submarine warfare ship project, Adm. Hayward said.

One feature of the Gilfillan contract calls for a weekly status report on the program to top-level Navy development officers in Washington.

Adm. Hayward said the acceleration efforts consist of trying several technical approaches to a problem rather than applying computer-supported management techniques such as PERT.

understanding of the requirement for duplication."

Adm. Hayward said the exercise begun by Charles J. Hitch, Department of Defense controller, in forcing the Pentagon to lay out and cost its programs through 1970 is proving of considerable value to the services.

"These are difficult questions to answer," he said, "but these costs can be bracketed. Thus we will have some sort of handle on future requirements."

Satellite Drift Data

Washington—Satellites in a synchronous equatorial orbit will require continuous application of thrust to maintain their longitudinal (hovering) position due to ellipticity of the earth around the equator, H. F. Michielsen of Lockheed Missiles and Space Co. reported here at last week's International Astronautical Congress.

Present data indicates that the major axis of the equator, believed to be located approximately 15-30 deg. west of Greenwich, is estimated to be 600 ft. longer than the minor axis, producing a lateral acceleration at 22,300-mi. altitude of about 0.000016 cm./sec./sec., Michielsen reported. This would cause satellite to drift about 1,800 ft., or 8.25 min. of arc, per day. The effect is most pronounced when satellite is located at an angle of 45 deg. to the principal axis.

If three satellites are used for a space communication system, two of them necessarily would be subject to drift caused by equatorial ellipticity. Michielsen estimated that weight of propellant needed to compensate for this drift would not exceed 0.25% of vehicle total weight.

Defense Agency Expects to Speed Delivery of Operational Weapons

New York—Recent creation of the Defense Supply Agency and decision to form a Logistics Management Institute composed of top-level business and industrial executives have been cited by Deputy Defense Secretary Roswell L. Gilpatric as key Defense Department moves "to put its own house in order."

"With the international situation so critical and defense needs so urgent," Gilpatric told guests at the 18th annual National Security Industrial Assn. dinner here, "what we want now is prompt delivery of weapons which fully measure up to specifications."

The Defense Supply Agency, designed to eliminate delays in materiel handling and supply duplication among the services, will assume functions of the Armed Forces Supply Support Center, existing and future integrated commodity management agencies ("single managers"), the Military Traffic Management Agency, surplus sales offices and the common services of cataloging, standardization and systems planning.

When it is fully operational, Gilpatric said, the agency will employ about 13,000 people, manage $4 billion of inventories and procure about $2½ billion in new stocks each year.

Initially, the agency has been assigned management responsibility for clothing, subsistence, petroleum, and medical, industrial, automotive, construction and general supplies. Electrical and electronic materials will be added as soon as possible, Gilpatric noted.

Also under study for assignment to the agency's control are industrial production equipment, chemical supplies and aviation spares, the deputy secretary said. His inclusion of aviation spares in this list may be an indication of major changes in the responsibility of service commands charged with aviation supply handling, particularly Air Force Logistics Command.

Should the last three categories be included under the new agency, Gilpatric said, the organization would manage inventories of more than $20 billion with an annual turnover of $4-5 billion and thus would become one of the biggest single customers for the nation's defense industries.

To trim away unnecessary procurement costs and weapon system delivery delays, Gilpatric remarked, DOD is directing its principal efforts toward "increasing incentives for economy and efficiency, both in terms of cost reduction and quality of the product."

Gilpatric said that DOD will stress fixed-price contracts with incentive fees to spur industry to reduce costs and delays.

"Under our economic system the profit motive is the strongest incentive for economy and efficiency, and the fixed-price contract best harnesses that incentive because it carries the greatest opportunity for profit and the greatest risk of loss," Gilpatric observed.

"But even where the cost reimbursement type contract has to be used, there are possibilities for introducing incentives," he said. "This can be done through an incentive fee, instead of a fixed fee. Where the savings clearly warrant and the contractor agrees to share in the cost overruns, the incentive fee could range up to the statutory maximum of 15% of estimated costs."

The deputy secretary said a Logistics Management Institute would be formed and would be headed by Charles H. Kellstadt, board chairman of Sears Roebuck and Co.

The advisory agency, which will probably work out of the Pentagon and report directly to Defense Secretary Robert McNamara, will be supported by a DOD contract, scheduled for issuance in a few days.

"This organization will be a nonprofit, fact-finding and research body guided by a group of trustees of national reputation," Gilpatric said.

Assistant Secretary Arthur Sylvester, DOD's public affairs chief, said Kellstadt probably will have almost complete freedom in selecting other members of the institute. Kellstadt will serve as chairman, with a director, as yet unnamed, as his deputy.

Final size of the agency has not yet been determined, Sylvester added.

Nike Zeus Future

Defense Secretary Robert S. McNamara is preparing a recommendation for President Kennedy on whether to authorize initial production of Nike Zeus anti-ICBM missiles in Fiscal 1963. New technical evaluation of Zeus conducted by Dr. Jack P. Ruina, director of Advanced Research Projects Agency, shows no significant change from last year's appraisal.

Using new target discrimination techniques, the missile is expected to provide some measure of ICBM defense capability, but not as much as some of its supporters claim. However, increased international tension and reported progress by the Soviets on an ICBM defense missile, prompts speculation that the President will recommend at least initial production of the weapon.

High-Priority Military Space Pace Urged

By Russell Hawkes

San Francisco—Present U. S. emphasis on peaceful use of space and the assignment of secondary importance to military space developments must be abandoned, the Air Force Systems Command Science and Engineering Symposium was told by Trevor Gardner, consultant to the Air Force Scientific Advisory Board.

Gardner said the Defense Department should be urged to start new high priority military space programs. Many qualified people have said that there is little or no practical military use for space flight capability but Gardner observed that predictions of the technological future have seldom been accurate. He cited the prediction of Dr. Albert Einstein that fission bombs would always be so heavy that they would have to be carried by ships and the prediction of Dr. Vannevar Bush that rockets could never span a continent. The development by the Soviets of the fission bomb, thermonuclear bomb, supersonic aircraft, ICBM, Sputniks, circumlunar flight, and the Vostoks came as a succession of surprises to many U. S. experts.

With these things in mind, Gardner said it would be a mistake to restrict military space developments to hasty adaptations of scientific systems.

He said, "in the growth of aviation, commercial aircraft have generally been an accidental by-product of military developments. It is frightening that in the vital field of space power the reverse may occur, with military space developments an accidental by-product of scientific space experiments.

"Individually and as a nation working through its bureaucracies, it is clear that we have not been as wise as we might have been in foreseeing the future. It is also clear that in the space field enough facts and informed technical intuition are available so that we need not perpetuate our history of underestimating the possibilities of the future," he said.

In addition to starting new space programs for defense, Gardner said the Administration should speed up existing ones and should sharply increase military participation in NASA programs and in lunar activities. Those programs that now emphasize scientific experimentation should be changed to assure that results will have the utmost military usefulnesss.

Gardner said, "our government must assure that our security needs in space power are accorded a more substantial position in the present programing and future planning of our space investment. The long dormant and now reinvigorated Space Council is the logical policy focal point for this critical problem. The Space Council must recognize and deal with this national security need by action that clarifies our now muddled space for peace policies."

Gardner attacked the multiplicity of government-organized study committees and pointed out that no booster rocket development program to satisfy military security requirements has yet emerged. He called for "experienced executive decisions, not diluted group evaluations of well understood fact. We need professionals and 'doers' in this field."

The most pressing military need is for large booster rockets designed for warfare. Gardner called it the central and immediate technical deficiency of U. S. space power and urged a crash program to develop liquid, solid and nuclear boosters. The large boosters now being developed may not be suitable for military applications. He said the thrust spectrum for military space boosters ranges from 800,000 lb. thrust to 10 million lb. thrust.

The basic capabilities needed for military space missions include:

- **Ability to orbit,** maneuver, rendezvous, de-orbit, re-enter and land.
- **Means of transportation** between spacecraft.
- **Methods of navigating** and communicating in deep space.
- **Standardized launch vehicles** and techniques that can meet the military need for sudden and repeated launch operations.
- **Ability to support** prolonged flight of manned spacecraft.

Gardner said that we must be able to exercise these capabilities on a routine basis. While noting that space programs will involve scientific experiments, he said that these routine space operations should be conducted by the defense establishment.

He pointed out that military personnel have been used in the first U. S. and Soviet manned space flights. This was the logical result of the fact that military aviation operating conventional aircraft has already developed the base of experience for the selection and training of crews in the disciplines of space flight. He pointed out that the U. S. now has only a limited program to exploit this experience and urged that it be expanded.

To acquire more experience of the actual space environment, Gardner suggested a series of manned space experiments like the Discoverer series in which orbital rendezvous and transfer of personnel would be performed frequently. One such experiment a month would not be an excessive schedule, he said. The military missions that can now be identified as requirements are:

- **Communication.**
- **Reconnaissance.**
- **Meteorology.**
- **Defense against attack from space.**
- **Manned space systems.**

Gardner said we must improve our ability to acquire and identify hostile satellites and spacecraft and must be able to track them through space maneuvers and orbit perturbations. Also needed is the ability to neutralize, capture, or destroy friendly or unfriendly satellites. Gardner said the U. S. must begin developing these capabilities and defining a global space defense system immediately.

Soviet Atomic Subs

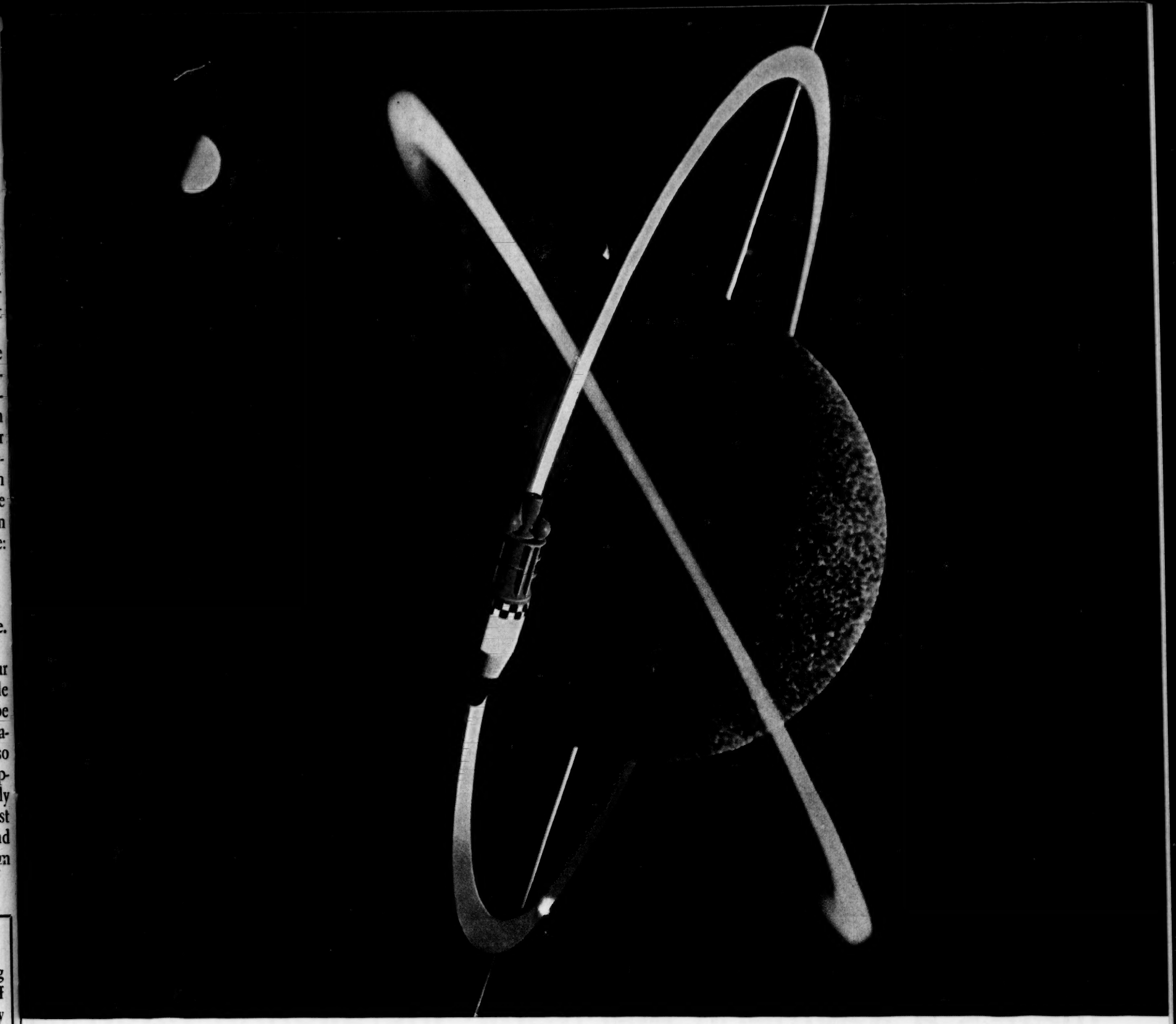
Moscow—Soviet Russia has missile-firing, nuclear-powered submarines "which develop a speed not inferior but superior to that of the American ones, and in no less quantity," Admiral Golovko wrote in the official military publication Red Star. The U. S. now has 21 nuclear-powered submarines in commission and will have another by the end of this year. This is believed to be the first time that Russia has claimed to have anything like the number of nuclear-powered subs that the U. S. has.

Ionosphere Reflection

New York—Technique for reflecting very high and ultra high frequencies off the ionosphere is being developed by Sperry Gyroscope Co., Great Neck, N.Y.

Sperry said that the method involves inhibiting the ion decay rate of an ionized cloud within the ionosphere by pumping microwave energy into the plasma. The energy would be absorbed by the clouds, formed originally either by meteoroids entering earth's atmosphere or by "seeding" chemicals carried aloft by small rockets, and sustain an ionized region about 1 km. in diameter for several hours. Central to the technique is the pumping system, which the company said consisted of "two microwave beams"—presumably two different frequencies—transmitting over a single antenna. Full details, the company said, are presently being withheld for proprietary reasons.

Sperry engineers said that the technique could raise the communications band capacity by 100 mc., from the high kilocycle to the 200-mc. region. It would allow telephone and television transmissions over distances of 1,000 mi. or more, the company said.



Bell-powered Agena satellites in orbit — symbolized.

THE ENGINE WITH THE FUTURE

Reliability . . . Efficiency . . . Flexibility.
In space, these words have a million-dollar meaning.

Vast sums of money and vital scientific data ride on these built-in attributes of Bell Aerosystem's rocket engine for Lockheed's Agena satellite, second stage of the Air Force Discoverer series.

The Agena engine, designed with space in mind long before space became a household word, has fulfilled its every mission and has placed more tons of useful payload into orbit than any other power plant. Its operational reliability is backed by six years of development and 5,000 test firings.

This Bell engine now has re-start capability -— the first in the nation. This means that its satellite can change orbit **in space** without the penalty of extra engines. Presently in production, this engine also is adaptable to new fuels and new assignments and, consequently, is programmed for important military and peaceful space ventures of the future.

Agena's engine is typical of the exciting projects in Bell's rocket propulsion center. It is part of the dynamic new approach of a company that's forging ahead in rocketry, avionics and space techniques. These skills serve all government agencies. Engineers and scientists anxious for a new kind of personal challenge can find it at Bell.

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Transit IV-A Proves Equator Is Elliptical

By Larry Booda

Washington — Navy's experimental navigation satellite Transit IV-A, launched last June 29, has proved that the earth's equator is elliptical in shape rather than circular, settling a long-standing scientific controversy among geodesists.

A single day's data from the Transit system is sufficient to show that the earth's diameter through the equator is 1,000 ft. wider than its narrowest point.

This anomaly has profound effects on the accuracy of long-range missiles where the exact distance from launch point to target must be known, even though the figure is relatively minor in comparison to the earth's size. It also affects accuracy of space shots to the moon and other planets.

Further refinements in the data obtained from satellites are expected to come from the projected Anna geodetic satellite, which is being planned for 1963. Anna is specifically aimed at highly accurate measurements of the earth's surface. It will not only use doppler effect radio as does Transit, but will also have a brightly flashing light to allow optical sighting at night.

The newly determined long axis of the equator runs from 11 deg. West Longitude, south of Liberia on Africa's west coast, to 169 deg. East Longitude, a point close to Nauru Atoll and west of the Gilbert Islands. The short axis would run from 101 deg. West Longitude, west of the Galapagos Islands, to 79 deg. East Longitude, south of the island of Ceylon.

This means that sea level is 500 ft. "higher"—or further from the earth's center—south of Liberia than at the Galapagos Islands.

First positive indications of the degree of ellipticity of the equator were discovered by Imre Izsak of the Smithsonian Astrophysical Observatory through optical observations of satellites. He indicated the ellipticity could be as much as 1,000 ft.

Since the launching of Transit IV-A in an "ideal" orbit with an inclination of 66.68 deg., an apogee of 546 naut. mi. and perigee of 484 naut. mi., tracking stations using the transmissions from the satellite's four transmitters have been able to observe its orbital perturbations almost continuously.

According to Dr. Robert R. Newton of the Johns Hopkins University Applied Physics Laboratory, which has charge of the project for the Navy, not only can calculations of the ellipticity be obtained from any single day of tracking but they can be obtained again to check previous results.

Previous indications of the ellipticity were obtained from Transit II-A which was launched June 22, 1960. At that time, however, the tracking stations were located on a narrow band of longitude. From the data available then it was not possible to make an estimate of the anomaly.

Perturbations in the orbit of the Transit satellite are recorded at the tracking stations. The Transit system makes use of the doppler effect of radio to help ships at sea accurately determine their positions. As the satellite passes over, the stations transmit the data recorded from it to the Applied Physics Laboratory, which computes the satellite's track. In navigational use this data would be transmitted to the satellite at regular intervals for relay to ships' computers.

The previously computed satellite tracks are based on a theoretically symmetric earth's surface. In geodesy this is called the ellipsoid. The ellipsoid is based on the principle that if the world were all water, the water would seek a certain level. That level is the ellipsoid, so called because the earth is "flattened" at the poles and bulges at the equator. Thus irregularities in the earth's surface are not taken into account in the computations.

Also used by geodesists is the geoid. Because of differences in gravitational attraction over the surface of the earth, the line of pull of gravitation may not pass through the center of the earth. A line perpendicular to this line of pull would be the surface of the geoid. The geoid, therefore, is a varying surface, reflecting "excesses" and "deficiencies" in the earth's mass.

The Transit orbit perturbations are plotted as "along-track" error. Superimposed over geographical points these plots can be analyzed to indicate the distance of the earth's surface from its center.

Using this data alone, however, does not make it possible to estimate ellipticity completely, because the perturbations include effects of what geodesists call tesseral harmonics. Harmonics are variations appearing in any method of measuring the earth's surface caused by the "excesses" or "deficiencies" in the earth's mass. Measured in one direction they are called zonal harmonics. In another direction they are sectorial harmonics. The combination of the two becomes tesseral harmonics.

More exact estimation of ellipticity is also made difficult at present by differences in the gravitational attraction of the earth, which varies from point to point, and by the geometric locations of the tracking stations which vary in height from the symmetric earth mentioned above.

The Transit doppler system is sensitive to both effects. It will take some time, however, to calculate these values and apply them to the determination of ellipticity.

Discovery of the ellipticity of the equator has resulted in adding two axes to the earth, making it triaxial. Previously only the axis about which it rotated was recognized. Now the long and short axes of the equatorial ellipse will become part of the geodesists' nomenclature. Only a year ago the earth was discovered to be "pear shaped."

Two of the four transmitters of Transit IV-A are being powered by the first nuclear power unit to be put into space by the U. S.; the other two by solar cells. Two piggyback satellites were sent aloft with Transit IV-A. One is Injun, which is designed to measure cosmic rays, solar protons and charged particles of the Van Allen radiation belt and to study origins of the Aurora. The other satellite is Greb III, which measures solar X-ray radiation to relate its intensity to changes in the ionosphere.

L-T-V Gets Follow-on Range Station Awards

Dallas, Tex.—Missile range support contracts totaling $11.6 million have been granted Ling-Temco-Vought, Inc., by Air Force Systems Command and the U. S. Navy Purchasing Office, Los Angeles.

Range Systems Division of Chance Vought Corp., an L-T-V subsidiary, has been awarded a $7.6-million contract by Navy covering continued operation and maintenance work on Kwajalein Island in the Marshall Island group and Kauai Island of the Hawaiian chain. Chance Vought's largest operation in this area is on Kwajalein, where the company will operate and maintain the telemetry station communications and data transmission systems, photo laboratory, operations control and frequency interference centers relating to Nike Zeus firings against Atlas ICBMs. In the Hawaiian group, the company will work on projects covering Mercury tracking and Regulus I submarine firing operations as well as deep space probes and satellite tracking.

Temco Aerosystems, another L-T-V division, has received a $1-million contract from AFSC for support in testing Army guided missiles on the Atlantic Missile Range. This is in addition to $3 million awarded for support of other AMR activities.

Astronaut Ties Mercury Research To Supersonic Transport Program

Los Angeles—"Some of the research done on Project Mercury would aid in development of a supersonic transport," America's first astronaut, Cdr. Alan B. Shepard, said at the Society of Experimental Test Pilots symposium on the supersonic transport.

Shepard said research on high-temperature structures and pilot display methods undoubtedly will prove of aid in the construction of a Mach 3 transport and reiterated his conviction that man is able to function, and function well, in space and that he is a valuable part in the control system loop and not merely a burdensome fixture (AW May 15, p. 31). Further proof of this will be coming in the orbital Mercury-Atlas shot due before the end of this year, Shepard said. Rather than giving man less to do in forthcoming space missions, he contended, it appears practical from a control standpoint to give the pilot control of the booster engine during the complete liftoff and earth-escape portion of the flight.

In a luncheon speech during the symposium, Federal Aviation Agency Administrator Najeeb E. Halaby announced establishment of a supersonic transport program management office headed by USAF Col. Lucian S. Rochte who has been on duty with the FAA for over two years. He will be the administrator's principal adviser on supersonic transport matters and also will give direction and control to the agency's supersonic transport activities.

Halaby also revealed that he recently formed a supersonic transport advisory group with Gen. Orval Cook, USAF (ret.) as its head following his retirement as president of the Aerospace Industries Assn.

"Because the modern test pilot is likely to know a great deal about aircraft of the future," Halaby asked the society to nominate one of its members to elaborate on the pilot's views regarding the supersonic transport. To this the society's newly elected president, William M. Magruder, Douglas chief engineering pilot, suggested Alvin White, who is the former president of the society and North American Aviation B-70 project pilot. Magruder further declared, however, that the cooperation of the society as a whole would be extended the FAA rather than the services of one individual.

W. P. Thayer, president of Chance Vought Div. of Ling-Temco-Vought, discussed a long-smoldering controversy—the deterioration of the relationship between military and industry test pilot teams (AW Apr. 17, p. 31). Whether or not the military domination of flight testing is a blow to free enterprise is not the problem, Thayer contended, but rather the problem is whether or not a better product can be given the military sooner through company-operated testing programs.

Some industry members seem to feel that the Air Force intends to take over all flight testing from first flights onward although this has not been officially confirmed. Indications are that the Air Force intends to have a military test pilot at the controls of the B-70 for its first flight scheduled next year and the individual, although not officially named, shortly will take up new duties in this connection under the Air Force Logistics Command.

Thayer said that the problem exists because "the military and industry don't agree on the best way to reach the common objective which is to bring out the best system and put it into use." There are extremists on both sides, some of whom favor discontinuing company testing and others who favor discontinuing military testing. Both are wide of the mark, Thayer claimed.

The real answer is that there is a need for both military and industry test teams—the military because it often operates weapon systems in extremes where the contractor does not, and industry because of valuable inputs to the system which ordinarily might not come to light. To back up the latter, Thayer pointed out that improvements often are made in aircraft outside contractual requirements as a result of company test programs. "This valuable improvement possibility I am sure the government doesn't want to lose," Thayer added. Industry needs a testing program for these reasons, Thayer said:

- **Contractual compliance** is not provable without a capable company testing organization. The company has a right, Thayer contends, to determine that its product functions properly before turning it over to the customer and it is necessary for the contractor to document its contractual compliance.
- **Improvements as a result** of flight testing must be fed back into the company for product improvement. Too often, Thayer said, companies are dominated by production or engineering and almost never by flight testing. If an opportunity is not afforded for testing the product, these inputs cannot be fed back into production or engineering.
- **Test pilots** are a source of management talent. Thayer himself started with Chance Vought as a test pilot after World War II Marine Corps service.

While not offering any solution to the deterioration of the relationship between the military and industrial testing teams, Thayer said he was going to endeavor to bring about a solution by airing his feeling to the military through the Aerospace Industries Assn. and he urged those present to do the same. Top management in neither the military nor industry realize there is a problem, Thayer said. Most of the disagreement is between working level personnel on both sides of the team.

Thayer asked the society which is composed about evenly of military and civilian test pilots to "come up with the facts on both sides of the issue and to see that these facts are used as the basis for a decision."

Soviet Tests Total 17

Washington—Soviet Union on Oct. 4 fired the 17th nuclear blast of its current test series, an atmospheric explosion with a yield of several megatons. The Atomic Energy Commission said the blast, set off in the Arctic testing ground near Novaya Zemlya, was one of the largest of the series. Meanwhile, a broadcast to Soviet forces Sept. 27 said: "In the Soviet Union plans have been worked out for serial production of nuclear bombs with increased power; 20, 30, 50 and 100 million tons of TNT."

Westland Drops Plans for 192C Helicopter

London—Westland Aircraft has dropped plans to build its 192C civil version of the Belvedere helicopter in favor of a sales and licensing agreement with Boeing for the Boeing Vertol 107. The 10-year pact gives Westland rights to market the 107 in Europe and the Commonwealth.

Belvedere was dropped after British European Airways evaluated the 192C, Sikorsky S-61 and Vertol 107, choosing the 107. The airline has asked the Treasury for permission to spend about $1 million for three 107s to start London-Brussels-Paris service jointly with Sabena but the deal is still under government wraps.

Sabena would buy two 107s under the plan. The five would be U. S.-built.

The Vertol 107 could be in production in the U.K. in three years, probably powered by de Havilland Gnome turbines, although the General Electric T58-8 also will be offered.

Successful X-15 Flight Recorded Without Detachable Ventral Fin

Edwards AFB, Calif. – Successful flight Oct. 4 in the North American X-15 research aircraft tested its handling qualities with the detachable ventral fin off. An earlier flight tested its ability to withstand skin temperatures up to 1,050F.

The test without the ventral fin was made because calculations indicated that if the airplane's stability augmentation system should fail in some future flight, it would be more stable with the fin jettisoned. Simulator tests indicated jettisoning would be a safe procedure. Test Pilot Maj. Robert A. Rushworth said that the X-15 handled even better during the eight-minute flight than simulator test flights had shown it would.

The flight went to a maximum speed of 2,850 mph. or Mach 4.3 at 74,000 ft. The maximum altitude reached was 79,000 ft. Burning time of the XLR-99 rocket engine was 120 sec.

Shortly before burnout Maj. Rushworth turned the pitch channel of the stability augmentation system to zero. After burnout and just before his final approach he turned down both the pitch and yaw channels. No decision has been made about whether to run a fin-jettisoned test with the stability augmentation system turned off completely.

Earlier Test

An earlier test flight by Cdr. Forrest Petersen was made to subject the airplane to aerodynamic heating temperatures 200F higher than the maximum previously experienced. A temperature of 1,050F was measured on the lower speed brake when the peak airspeed of 3,435 mph. was reached. The highest temperature recorded on the wing was 950F.

Design limit temperature for the X-15 is 1,200F.

The flight began with a 73-sec. run at 100% power after which Cdr. Petersen reduced power to 50% and extended the speed brakes. Maximum speed was Mach 5.25 at 82,000 ft. The top altitude reached was 100,000 ft. Cdr. Petersen reported that smoke from blistering paint in the cockpit interfered with visibility briefly before being ejected with the gaseous nitrogen that pressurizes the cockpit and cools electronics.

Photo Emulsion Packages

NASA has announced that all X-15 flights above 80,000 ft. are now carrying photo emulsion packages to measure cosmic radiation and perhaps the lower edge of the inner Van Allen belt. No special installations are required for the experiments. NASA Goddard Space Flight Center is measuring high-altitude cosmic primary radiation on flights that exceed 100,000 ft. with emulsion packages carried at the aft end of the angular side bearings of the X-15. North American Aviation is measuring cosmic albedo in flights above 80,000 ft. with packages mounted in the cockpit, the instrumentation bay and the lower camera bay.

Gyroplane Rating

Washington—Federal Aviation Agency has proposed delineation of rotorcraft pilot ratings into helicopter and "gyroplane" classes.

The move apparently was caused by the recent certification of the Umbaugh U-18 autogyro. The FAA proposal defines helicopters as rotorcraft which depend for lift mainly on a powered rotor and gyroplanes as rotorcraft in which the lift is provided mainly by a rotor which is unpowered except for initial starting and which is rotated by the action of the air when the craft is in motion.

In proposing the new regulation, the FAA notes that the majority of rotorcraft presently flying are helicopters.

"However, there are some gyroplanes [flying now], and indications are that there will be many others in the near future," the proposal continues. The FAA proposal does not elaborate, but obviously refers to the volume production rate proposed by Umbaugh for the U-18.

At present, the FAA makes no distinction between helicopters and gyroplanes in granting rotorcraft ratings. The proposal notes, however, that the differences between the flight characteristics of helicopters and gyroplanes are at least as great as those between different classes of airplanes.

No pilot requirements for the gyroplane rating will be established unless and until the new rule is adopted.

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News Digest

Minneapolis-Honeywell's Centaur guidance package made its first flight last week in a pod on the side of a Convair Atlas-E missile fired over the Atlantic Missile Range and achieved all primary missions. Package telemetered its performance results but did not control the missile.

First recovery of an object from a missile nose cone fired 9,000 mi. was made last week when the data cassette of an Avco Mk.4, launched from Cape Canaveral, Fla., by a USAF-Convair Atlas E, was spotted in the Indian Ocean by a JC-54 aircraft 1 hr. 29 min. after launch and retrieved 3 hr. 8 min. after launch by the range ship Coastal Sentry. This was the fourth Atlas shot of 9,000 mi. or more.

Civil Aeronautics Board last week deferred public disclosure of documents filed by Northeast Airlines, Atlas Corp. and Hughes Tool Co. but authorized the group to withdraw its application for a disclaimer of jurisdiction. Earlier, the CAB gave Howard Hughes, owner of Hughes Tool, until Nov. 30 to get rid of his Atlas stock.

Continental Can Co., Inc., Morristown, N. J., has canceled its order for a Lockheed JetStar. Among the factors influencing the decision to cancel the order are the recall of Gen. Lucius D. Clay, chairman of the board, to federal service in Berlin and an ordnance prohibiting jet aircraft operating from Morristown Airport, N. J.

Dr. William H. Pickering has been elected president of the American Rocket Society. He will succeed Dr. Harold W. Ritchey next Jan. 1. Pickering is director of the California Institute of Technology's Jet Propulsion Laboratory.

General Electric has been awarded a Federal Aviation Agency type certificate for its CJ-805-23B turbofan, an improved version of the engine slated for the Convair 990s to be acquired by American Airlines. American plans to incorporate -23B improvements at first engine overhaul, while 990s ordered by Swissair, SAS and Varig, and Caravelle 10As bought by TWA will be delivered with the new powerplant.

Boeing Co. has created a new division, Military Aircraft Systems Division, to consolidate the military aircraft activities of the Wichita and Aero-Space Divisions. Boeing Vice President E. C. Wells will be the division's general manager.

Airlines Split on Foreign Carrier Curbs

Proposed legislation to control capacity and rates creates division over extent of government's role.

By L. L. Doty

Washington—Drive by U. S. international airlines for legislation that would curb capacity and control rates of foreign flag competitors has been slowed by an industry split over the provisions of such legislation.

Chief difference is over how far individual U. S. carriers want the federal government to go in establishing the controls necessary to restrict capacity of foreign flag carriers serving U. S. gateways and to set rate minimums. Specifically, it is a breach between airlines that favor a complete freedom-of-the-skies philosophy and those that support a policy of moderate government protective regulation.

Proposed legislation has been drafted by the industry. Plans were to submit the draft to the White House before the next session of Congress in the hope of winning Administration backing. But it now appears that these plans have been all but scuttled by carriers who fear that the legislation would only tighten government control over the industry.

Capacity and rates are unquestionably the two principal issues at stake in the current struggle between U. S. and foreign airlines. In a meeting late last summer between the Civil Aeronautics Board and representatives of six airlines —Braniff, Northwest, Pan American, Seaboard World, Panagra and TWA— these two elements were the most frequently emphasized in the discussions on international transportation problems.

Amendment Proposed

It was generally assumed from the unanimity implicit during the meeting that new legislation could be drafted that industry would support. In the case of capacity, it was decided to propose an amendment to Section 402 of the Federal Aviation Act that would require foreign flag carriers to file with the CAB all schedules of flights operating between the U. S. and points beyond.

CAB is currently conducting an investigation to determine whether it should require foreign flag carriers to submit not only schedules but traffic statistics.

Under the proposed legislation, foreign flag carriers would be required to gain CAB approval of all schedules to and from the U. S. before they could be effective. The Board would base its approval or disapproval on whether the schedules adversely affect the public interest of the U. S. or are in violation of any treaty, convention or agreement in force between the U. S. and the foreign nation involved.

Previous U. S. attempts to prove that several European carriers were in violation of their governments' bilateral agreement with the U. S. flatly failed. No decisions were reached and several European carriers have combined forces to oppose in principle the charges of violation.

As a consequence, several U. S. airlines feel that legislation designed to enforce the U. S. position in international civil aviation will merely result in retaliation from other governments. As it is, several countries outside of Europe have imposed capacity restrictions against the U. S. to protect their flag carriers. Although the U. S. has lodged formal complaints with these countries on grounds that such restrictions violate their bilateral agreements with the U. S., American flag carriers, ironically, have been forced to bow to these controls.

Rate Control Position

Several airlines have concluded that this may be the time to review the long-standing industry position against any CAB control of rates. To mollify carriers which are violently opposed to any form of additional control, it was proposed that the new legislation empower the Board to suspend the rates of either foreign flag or U. S. carriers, but grant it no authority to fix international rates.

Specifically, the proposed draft would empower the Board to suspend rates of any carrier serving the U. S. for a period as long as one year, whether it is a proposed or existing tariff, if such rates appear to be against the public interest.

It is not surprising that this draft has met stiff opposition by some carriers. The industry traditionally has fought any moves made in the past to give the Board such power and, although a few carriers may have shifted their stands because of uncontrolled price-cutting

Chalk Buys Into Caribair; BWIA-BOAC Meet

Transportation Corp. of America, headed by New York Financier O. Roy Chalk, is widening its interests in Caribbean air transport at the same time that British Overseas Airways Corp. is beginning negotiation of the sale of its wholly owned subsidiary in the area.

The U. S. company is acquiring 16.18% of the common stock or 15,300 shares of Caribair—Caribbean Atlantic Airways, Inc. (AW Sept. 18, p. 42)—from Henry L. Kimelman and a group of associates in exchange for 32,332 shares of Transportation Corp. Class A stock.

Kimelman is the largest private stockholder in Leeward Islands Air Transport, a subsidiary of British West Indian Airways that in turn is a wholly owned subsidiary of British Overseas Airways Corp.

Though not directly related, both the BOAC-BWIA talks in Trinidad and the Caribair exchange indicate fundamental changes are in store for Caribbean air transport. Outlook for a federal airline, presumably built around BWIA, for the nascent West Indies Federation suffered when Jamaica voted last month not to join the federation, leaving it bereft of a strong and vitally needed island. Jamaica had shown preference for designating BOAC as its chosen instrument (AW June 12, p. 42).

BOAC is seeking about $7.5 million for 51% of BWIA's stock.

Transportation Corp.'s airline, Trans Caribbean Airways, operates scheduled passenger service between New York and Puerto Rico with connections via Caribair to the Virgin Islands and its burgeoning tourist traffic and with other Caribbean points served by Caribair. Trans-Caribbean will inaugurate service with turbofan-powered DC-8s to Puerto Rico Nov. 10.

Caribair has 94,538 shares of stock outstanding, 51.12% of it owned by the Trigo family of San Juan. Laurance Rockefeller, who has interests in the Virgin Islands and donated land for a national park there, also owns an interest in Caribair.

by some foreign carriers, industry-wide support of the proposal is not likely.

In his testimony before the one-day hearings conducted by a Senate subcommittee on aviation (AW Oct. 2, p. 37), CAB Chairman Alan S. Boyd said that the Board has not construed the Federal Aviation Act of 1958 as empowering it to fix rates in foreign air transportation. International rates now are determined by the Traffic Conference of the International Air Transport Assn., subject to government approval.

Under most bilateral agreements signed by the U. S., a government that is dissatisfied with a disputed rate can prevent that rate from being effective.

Board, State Views

But, because the Board is not permitted to fix rates, the U. S. is unable to prevent a rate proposed by a foreign government from becoming effective if consultation with that government results in no agreement, Boyd said.

"For some time, the Board has sought additional rate powers in foreign air transportation but to date has been unsuccessful in getting them," Boyd said.

"The Board is now considering the legal and policy aspects of instituting another proceeding looking to conditioning foreign carrier permits to empower the Board to suspend the effectiveness of a foreign carrier's proposed rate if it appears it would be inimical to sound economic conditions or constitute a destructive competitive practice."

Edward M. Martin, assistant secretary of state for economic affairs, said in the Senate hearings that a new rate article for bilateral agreements has been developed in a move to strengthen the U. S. position with respect to international rates. Martin added, however, that the new article falls short of the power needed to protect the U. S. against price-cutting, and he re-emphasized State Department's strong stand for legislation that would give the Board rate-making power in the international field.

Senate Action

With both the Board and the State Department renewing their demands for this rate authority, it now appears quite possible that the Senate aviation subcommittee, headed by Sen. A. S. Mike Monroney (D.-Okla.), may introduce a bill during the next session of Congress, follo[illegible] be usable[illegible]r hearings on internati[illegible]laced his hydon, that will give [illegible]tch in "emergency" [illegible]wer it wants.

DC-8 hydraulic compo[illegible]ppears highly were being subjected to [illegible] will enforce by Civil Aeronautics Bo[illegible]reign carriers at United Air Lines' [illegible]ecause of inmaintenance base. Co[illegible]nations.

Airline Presidents Clash with CAB On Unprofitable Promotional Fares

By Robert H. Cook

Washington—Airline presidents are deeply concerned over the results of promotional fares designed to attract a new mass market for air travel, and may soon move to abandon the controversial youth fare plan.

Six of the 13 presidents who recently attended a closed door discussion of industry problems with the Civil Aeronautics Board told AVIATION WEEK the complex of low-cost fares is attracting business, but at the expense of seriously diluting the industry's more profitable first-class earnings.

The airlines' unanimous description of the youth fare plan as "unworkable and disappointing" was one of the most hotly contested issues during the meeting, as the Board's philosophical support for promotional fares clashed with the airlines' criticism of the low profit yield.

Airline presidents gave a polite nod of approval to CAB overtures to help solve the industry's deteriorating financial condition, and emerged from the meeting agreed that any improvement will be a product of their own efforts.

At the same time, industry leaders conceded that Chairman Alan S. Boyd and the Board are making a sincere effort to aid the airlines, as evidenced by CAB's approval of another meeting between airline representatives and Board staff members to discuss the problems of "no-show" passengers and food service. Approval of the meeting was considered a bold move by CAB, since it permitted industry competitors to seek a common solution without fear of anti-trust prosecution.

The tenor of remarks by Boyd at a press conference following the meeting seemed to support industry speculation that the chairman might choose the occasion to assert his leadership by urging the airlines to accept many of his personal solutions of industry problems. This was particularly evident in the selection of food services for further discussion and Boyd's point blank observation that the airlines should "pay less attention to being a traveling dining room and more to transportation."

While admitting their surprise that the six-hour meeting was able to touch upon each item of its lengthy agenda, several airline presidents criticized CAB's attempts to cover so much territory in so little time. Others claimed major issues of importance received too little attention, but admitted reluctance to become too deeply involved in economic discussions in the presence of competitors.

In addition, "some disenchantment" was admitted by some presidents who had hoped the CAB might produce concrete ideas on competition, which most regard as their most pressing problem. None was forthcoming, but the Board advised the carriers that a detailed analysis of this problem has been under way by Board technicians for several months.

A majority of the presidents endorsed the general philosophy of the Board's new approach to the industry's problems, and said they were willing to attend further conferences.

Boyd's report of the talks emphasized that discussion was concentrated on passenger services, promotional fares, and domestic and international competition. The subject of cargo was deleted from the agenda at the last minute because the all-cargo carriers had not been invited, he said. The chairman indicated that CAB may discuss this matter with cargo airlines in the future.

Boyd singled out "no-shows" as one of the major problems of the industry, accounting for 11% of the tickets sold on domestic flights and 9% on international flights.

A solution could be "concentrated action" by the airlines to levy greater no-show penalties, he said. Past attempts to impose a $3 fine did not help, since veteran "expense account travelers" apparently considered the penalty insignificant. The chairman declined to suggest what the fine might be, but said it was suggested airlines might adopt a special reservation fee which would be refunded when the passenger boarded the airplane.

As a condition to any no-show penalties, Boyd said CAB would insist upon airline agreement to pay a set penalty whenever available seat space is oversold. He said that the carriers tacitly agreed and that the entire subject would be reviewed later by the airlines.

Boyd cautiously avoided identifying the remarks of any individual airline president, and reported only what he considered a "general consensus" of the carriers. However, he underscored much of his report with "personal opinion" which he noted as pertinent to the subjects discussed.

Airline food and beverage "frills" came under fire from Boyd, who said it was "difficult to appreciate the need of the carriers" to serve food on all flights. This is particularly true, he pointed out, where airlines serve elaborate meals to both coach and first-class passengers, although there is a much higher profit on first-class passen-

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CAB is currently conducting an investigation to determine whether it should require foreign flag carriers to submit not only schedules but traffic statistics.

Under the proposed legislation, foreign flag carriers would be required to gain CAB approval of all schedules to and from the U. S. before they could be effective. The Board would base its approval or disapproval on whether the schedules adversely affect the public interest of the U. S. or are in violation of any treaty, convention or agreement in force between the U. S. and the foreign nation involved.

Previous U. S. attempts to prove that several European carriers were in violation of their governments' bilateral agreement with the U. S. flatly failed. No decisions were reached and several European carriers have combined forces to oppose in principle the charges of violation.

As a consequence, several U. S. airlines feel that legislation designed to enforce the U. S. position in international civil aviation will merely result in retaliation from other governments. As it is, several countries outside of Europe have imposed capacity restrictions against the U. S. to protect their flag carriers. Although the U. S. has lodged formal complaints with these countries on grounds that such restrictions violate their bilateral agreements with the U. S., American flag carriers, ironically, have been forced to bow to these controls.

Rate Control Position

Several airlines have concluded that this may be the time to review the long-standing industry position against any CAB control of rates. To mollify carriers which are violently opposed to any form of additional control, it was proposed that the new legislation empower the Board to suspend the rates of either foreign flag or U. S. carriers, but grant it no authority to fix international rates.

Specifically, the proposed draft would empower the Board to suspend rates of any carrier serving the U. S. for a period as long as one year, whether it is a proposed or existing tariff, if such rates appear to be against the public interest.

It is not surprising that this draft has met stiff opposition by some carriers. The industry traditionally has fought any moves made in the past to give the Board such power and, although a few carriers may have shifted their stands because of uncontrolled price-cutting

Chalk Buys Into Caribair; BWIA-BOAC Meet

Transportation Corp. of America, headed by New York Financier O. Roy Chalk, is widening its interests in Caribbean air transport at the same time that British Overseas Airways Corp. is beginning negotiation of the sale of its wholly owned subsidiary in the area.

The U. S. company is acquiring 16.18% of the common stock or 15,300 shares of Caribair—Caribbean Atlantic Airways, Inc. (AW Sept. 18, p. 42)—from Henry L. Kimelman and a group of associates in exchange for 32,332 shares of Transportation Corp. Class A stock.

Kimelman is the largest private stockholder in Leeward Islands Air Transport, a subsidiary of British West Indian Airways that in turn is a wholly owned subsidiary of British Overseas Airways Corp.

Though not directly related, both the BOAC-BWIA talks in Trinidad and the Caribair exchange indicate fundamental changes are in store for Caribbean air transport. Outlook for a federal airline, presumably built around BWIA, for the nascent West Indies Federation suffered when Jamaica voted last month not to join the federation, leaving it bereft of a strong and vitally needed island. Jamaica had shown preference for designating BOAC as its chosen instrument (AW June 12, p. 42).

BOAC is seeking about $7.5 million for 51% of BWIA's stock.

Transportation Corp.'s airline, Trans Caribbean Airways, operates scheduled passenger service between New York and Puerto Rico with connections via Caribair to the Virgin Islands and its burgeoning tourist traffic and with other Caribbean points served by Caribair. Trans-Caribbean will inaugurate service with turbofan-powered DC-8s to Puerto Rico Nov. 10.

Caribair has 94,538 shares of stock outstanding, 51.12% of it owned by the Trigo family of San Juan. Laurance Rockefeller, who has interests in the Virgin Islands and donated land for a national park there, also owns an interest in Caribair.

by some foreign carriers, industry-wide support of the proposal is not likely.

In his testimony before the one-day hearings conducted by a Senate subcommittee on aviation (AW Oct. 2, p. 37), CAB Chairman Alan S. Boyd said that the Board has not construed the Federal Aviation Act of 1958 as empowering it to fix rates in foreign air transportation. International rates now are determined by the Traffic Conference of the International Air Transport Assn., subject to government approval.

Under most bilateral agreements signed by the U. S., a government that is dissatisfied with a disputed rate can prevent that rate from being effective.

Board, State Views

But, because the Board is not permitted to fix rates, the U. S. is unable to prevent a rate proposed by a foreign government from becoming effective if consultation with that government results in no agreement, Boyd said.

"For some time, the Board has sought additional rate powers in foreign air transportation but to date has been unsuccessful in getting them," Boyd said.

"The Board is now considering the legal and policy aspects of instituting another proceeding looking to conditioning foreign carrier permits to empower the Board to suspend the effectiveness of a foreign carrier's proposed rate if it appears it would be inimical to sound economic conditions or constitute a destructive competitive practice."

Edward M. Martin, assistant secretary of state for economic affairs, said in the Senate hearings that a new rate article for bilateral agreements has been developed in a move to strengthen the U. S. position with respect to international rates. Martin added, however, that the new article falls short of the power needed to protect the U. S. against price-cutting, and he re-emphasized State Department's strong stand for legislation that would give the Board rate-making power in the international field.

Senate Action

With both the Board and the State Department renewing their demands for this rate authority, it now appears quite possible that the Senate aviation subcommittee, headed by Sen. A. S. Mike Monroney (D.-Okla.), may introduce a bill during the next session of Congress, following further hearings on international civil aviation, that will give the Board the rate power it wants.

At the same time, it appears highly improbable that the U. S. will enforce capacity restrictions on foreign carriers through unilateral action because of international policy considerations.

Airline Presidents Clash with CAB On Unprofitable Promotional Fares

By Robert H. Cook

Washington—Airline presidents are deeply concerned over the results of promotional fares designed to attract a new mass market for air travel, and may soon move to abandon the controversial youth fare plan.

Six of the 13 presidents who recently attended a closed door discussion of industry problems with the Civil Aeronautics Board told AVIATION WEEK the complex of low-cost fares is attracting business, but at the expense of seriously diluting the industry's more profitable first-class earnings.

The airlines' unanimous description of the youth fare plan as "unworkable and disappointing" was one of the most hotly contested issues during the meeting, as the Board's philosophical support for promotional fares clashed with the airlines' criticism of the low profit yield.

Airline presidents gave a polite nod of approval to CAB overtures to help solve the industry's deteriorating financial condition, and emerged from the meeting agreed that any improvement will be a product of their own efforts.

At the same time, industry leaders conceded that Chairman Alan S. Boyd and the Board are making a sincere effort to aid the airlines, as evidenced by CAB's approval of another meeting between airline representatives and Board staff members to discuss the problems of "no-show" passengers and food service. Approval of the meeting was considered a bold move by CAB, since it permitted industry competitors to seek a common solution without fear of anti-trust prosecution.

The tenor of remarks by Boyd at a press conference following the meeting seemed to support industry speculation that the chairman might choose the occasion to assert his leadership by urging the airlines to accept many of his personal solutions of industry problems. This was particularly evident in the selection of food services for further discussion and Boyd's point blank observation that the airlines should "pay less attention to being a traveling dining room and more to transportation."

While admitting their surprise that the six-hour meeting was able to touch upon each item of its lengthy agenda, several airline presidents criticized CAB's attempts to cover so much territory in so little time. Others claimed major issues of importance received too little attention, but admitted reluctance to become too deeply involved in economic discussions in the presence of competitors.

In addition, "some disenchantment" was admitted by some presidents who had hoped the CAB might produce concrete ideas on competition, which most regard as their most pressing problem. None was forthcoming, but the Board advised the carriers that a detailed analysis of this problem has been under way by Board technicians for several months.

A majority of the presidents endorsed the general philosophy of the Board's new approach to the industry's problems, and said they were willing to attend further conferences.

Boyd's report of the talks emphasized that discussion was concentrated on passenger services, promotional fares, and domestic and international competition. The subject of cargo was deleted from the agenda at the last minute because the all-cargo carriers had not been invited, he said. The chairman indicated that CAB may discuss this matter with cargo airlines in the future.

Boyd singled out "no-shows" as one of the major problems of the industry, accounting for 11% of the tickets sold on domestic flights and 9% on international flights.

A solution could be "concentrated action" by the airlines to levy greater no-show penalties, he said. Past attempts to impose a $3 fine did not help, since veteran "expense account travelers" apparently considered the penalty insignificant. The chairman declined to suggest what the fine might be, but said it was suggested airlines might adopt a special reservation fee which would be refunded when the passenger boarded the airplane.

As a condition to any no-show penalties, Boyd said CAB would insist upon airline agreement to pay a set penalty whenever available seat space is oversold. He said that the carriers tacitly agreed and that the entire subject would be reviewed later by the airlines.

Boyd cautiously avoided identifving the remarks of any individual airline president, and reported only what he considered a "general consensus" of the carriers. However, he underscored much of his report with "personal opinion" which he noted as pertinent to the subjects discussed.

Airline food and beverage "frills" came under fire from Boyd, who said it was "difficult to appreciate the need of the carriers" to serve food on all flights. This is particularly true, he pointed out, where airlines serve elaborate meals to both coach and first-class passengers, although there is a much higher profit on first-class passen-

gers. Reducing coach costs by eliminating meals or serving a simple cold fare, such as sandwiches, might afford a significant saving which could be applied towards the airlines' debt and interest charges, he pointed out. He was non-committal on whether the airlines would live up to any agreement on this service, but said they are interested in exploring the matter further.

On the subject of promotional fares, consistently urged by Boyd and other CAB members, each airline president had a different story of how the half fare tariff had been abused by "ingenious youths," Boyd said. The most notable anecdote was the case of an airline president who saw a youth purchase a ticket at the counter, and minutes before the flight, hand it to his father, Boyd said.

All trunklines, with the exception of Eastern Air Lines, adopted the fare under CAB approval requiring the filing of traffic reports on the fare every three months.

As an example of airline disappointment in the youth fare plan, National Airlines recently notified the Board that preliminary traffic results indicate the airline was "over-optimistic" in its support of them. National said the resulting figures indicated an "unexpected dilution of revenue which is difficult to justify."

The airlines' thinking on a variety of other promotional fares, most of which CAB plans to review after six months operational experience, was not revealed by Boyd, but airline presidents interviewed by AVIATION WEEK gave no indication of dropping these low-cost fares.

The possibility of fare increases was not raised during the meeting, but Boyd noted that all presidents agreed "something" would have to be done to increase revenues.

Financial Fortunes

While the CAB has not indicated refusal to permit a return of any trunkline to subsidy, Boyd said, the airlines are "convinced" they would not be permitted to do so under the Board's present policies. While depressed over the failing state of their earnings the airlines are optimistic that their financial fortunes will "bounce back" on the strength of future population growth and a rising standard of living.

Competition in both the domestic and international fields was a major topic of the meeting, with several carriers claiming an excess of competition on parallel routes. Boyd declined to give any personal opinion on this matter, but pointed out that CAB has agreed to arrive at a "set of principles" on which to evaluate the effects of existing and future route competition.

Internationally, the problem of U. S. flag competition with foreign carriers is becoming "critical," the chairman noted. Boyd said that domestically the airlines have agreed to pool their aircraft replacement parts as an economy measure, and that while pooling of equipment or revenues are basically not in line with U. S. policy, "it is a question whether U. S. international carriers can continue to operate" without entering into pooling agreements among themselves or with some foreign airlines.

This solution is now under study by CAB and the Department of Justice, which will determine whether such an agreement would constitute a violation of anti-trust laws, Boyd said.

Boyd added that the U. S. flags are also suffering from "back door price cutting" by foreign airlines, most of which are either owned or controlled by their governments. Some progress has been made by CAB to offset the operational restrictions placed on U. S. carriers by foreign governments, but the Board has been unable to find a defense against price cutting, he said.

A majority of the airline presidents contacted by AVIATION WEEK preferred to remain anonymous but displayed no reluctance to air their views on the value of the meeting.

Reduce 'Frills'

On the subject of "frills," most agreed to the need to reduce them, but were apprehensive about all carriers honoring such an agreement. One noted that these "added niceties" designed to attract customers in the "era of 300-mph. piston aircraft" are now being applied "unnecessarily to 600-mph. turbojets." He added: "Transportation and speed are really our main products, but how do you keep people from competing with a competitive weapon we've used for years?"

All emphasized the need for "good faith" and generally agreed that holding such frills to turbojet service alone could be accomplished by general agreement.

Promotional fares were the subject of soul searching and caustic criticism on the part of most presidents. Most expressed concern that while they produced high load factors, their low profit yield and diversion from first-class revenues has already indicated they are a "losing deal."

"We've known for 30 years you can't market air travel like you do cigarettes," the president of one major trunk declared. "I personally doubt the existence of any mass market for air travel, on the basis of the industry's constantly rising operational costs and the cost of living of the average wage earner who would constitute a part of such a market. The idea behind promotional fares is fine, but they are definitely diluting our total revenues at the very time when they are needed the most," he said.

Industry Overburdened

The president of a coast-to-coast trunkline supported this stand, as did an international carrier. Another trunk president took the position that the industry is "way overburdened" with promotional fares, which should all be "washed out" and then reapplied only to piston engine aircraft flights.

Yet each of these airline executives made it clear that their airlines would hesitate to drop their special low fares —with the exception of the youth fare— because of fear their competitors would not drop them.

With the exception of international service, none of the airline presidents appeared to consider the no-shows cause for serious concern, but were in favor of any means to reduce the problem.

Competition, which a majority identified as their greatest worry, was discussed, but CAB "doesn't seem to know the answer," said one trunk leader.

"Look at the number of grandfather rights on the routes in this country and you'll get an idea of their [CAB's] problem," he said. "These rights can't be changed and for years the Board has been adding new competition over these rights, so that now we're paying the price of dividing up an economic pie of dimensions known several years ago, when costs were much lower to the industry. The hand-writing on the wall was there several years ago, but the Board didn't bother to read it."

Another president charged that the Board "really doesn't know what to do about this," while yet another observed that any formula evolved by CAB may be like asking a patient where he'd rather have an ailment, rather than offering a cure.

The president of an international carrier voiced strong support for pooling with his present U. S. competitor as a defense against mounting foreign competition. The Board's past policy of placing one U. S. international airline in direct competition with another on overseas routes is both "outdated and outmoded," he said. Pooling of both equipment and revenues on these routes would be preferable to the present competitive system which pits one against the other, resulting in low load factors in the face of heavy foreign competition, he said.

Viscounts for Red China?

Vickers Armstrongs is negotiating sale of Viscount turboprop transports to Red China. Vickers has had a team in Red China and Tzu Hua Wu, deputy director of Red China's Civil Aviation Administration visited the Vickers plant during the Farnborough show last month.

Douglas, FAA Urge Changes in DC-8s

Washington—Douglas Aircraft Co., in concert with Federal Aviation Agency, has urged that airlines operating DC-8s undertake major mechanical changes to rule out asymmetric reverse thrust as the cause of off-runway swerves after touchdown and to strengthen the aircraft's hydraulic system.

The Douglas proposals may be modified or even rescinded as a result of tests now under way. But the DC-8 manufacturer's recommendations, as received by company field representatives and airlines last week, add up to a sizable retrofit for the transport's hydraulic system and thrust reversers.

U. S. airlines continued to report instances of jets landing without hydraulic pressure during the week preceding and the week following Douglas' drafting of its DC-8 action program.

Key change called for by Douglas is a reverse thrust interlock. This device almost a system in itself, would ensure that the DC-8's thrust reverser buckets were fully closed before the plane's turbojets began producing thrust to slow the aircraft.

At the same time, the interlock would kick the pilot's thrust reverser lever to idle if for any reason the thrust buckets opened during in-flight or landing roll reversing. It also would incorporate a mechanical latch to hold the sliding DC-8 thrust ejectors in the full aft position during reversing operations.

DC-8 System

On the DC-8, thrust ejectors travel aft several feet when reverse thrust is called for by the pilot. When the ejectors have moved to the full aft position, the thrust reverser buckets they incorporate can be closed. At this point, the engine is prepared to produce reverse thrust. But if the pneumatically actuated buckets should open inadvertently, forward instead of reverse thrust would result. Boeing 707s use a different reversing system.

Separate sources of hydraulic pressure, Douglas said, should be installed to operate the DC-8's ground spoiler and rudder boost systems. Hydraulic pressure for rudder boost purposes should be generated by a separate pump fed by an independent fluid supply. Designed to backstop the DC-8's overall hydraulic system, this rudder boost system would be usable only when the pilot placed his hydraulic selector switch in "emergency" position.

DC-8 hydraulic components last week were being subjected to exhaustive tests by Civil Aeronautics Board technicians at United Air Lines' San Francisco maintenance base. Concurrently, Pan American World Airways was conducting static, simulated landing and reversing operations at New York International Airport to determine why one of its DC-8s veered off an Idlewild runway last month. Pending the outcome of these investigations, Douglas telegraphed the airlines on Sept. 30 to:

- **Provide** increased accumulator pressure to support the DC-8's hydraulic system.
- **Install** a separate accumulator in the hydraulically operated DC-8 nose gear steering system.
- **Add surge** dampening devices or pressure relief valves in critical areas of the DC-8 hydraulic system.
- **Replace** all DC-8 wing flap hydraulic actuating cylinders as soon as parts become available.
- **Connect** new teflon pressure hoses to the DC-8's engine-driven hydraulic pumps.
- **Acquire** a new type of gage to indicate the quantity of hydraulic fluid in the DC-8's reservoir.
- **Attend** a symposium on hydraulics to be conducted on Oct. 19-20 at Douglas' Long Beach, Calif., plant.

Also on Sept. 30, after a meeting with Douglas officials in Los Angeles, FAA Administrator N. E. Halaby announced that these directives had received his approval. In addition to summarizing the proposals of Douglas, Halaby disclosed that FAA planned to intensify its supervision of airline maintenance practices "to ensure the use of correct parts and procedures." He also said that FAA's testing of DC-8 pilots would continue in an effort to ensure that hydraulics-out emergency procedures were well known.

Pilot Refusal

Apparently angered by the 10-question, true-or-false tests being administered by FAA air carrier inspectors, the chairman of Eastern Air Line Pilots Assn. Council 18 in Miami earlier had wired Halaby that the 600 pilots he represented would refuse to fly DC-8s unless FAA certified them to be airworthy in writing.

While the pilots were drafting their telegram in Miami, Halaby told 400 members and guests of the Society of Experimental Test Pilots at a Los Angeles luncheon that he was personally convinced hydraulic systems of all jet transports had been designed, built and installed with the utmost care. He said that he could find no single source of trouble with the DC-8 hydraulic system in particular.

This assurance, an ALPA spokesman told AVIATION WEEK, satisfied the Council 18 pilots. FAA inspectors, meanwhile, were reported to have stopped insisting that the airline pilots sign their names to the hydraulic emergency procedures tests.

The Douglas recommendations for the DC-8 were forwarded to the industry on the afternoon Halaby concluded a long session with the company's top management. This, Halaby said, was to be followed by meetings with other jet transport manufacturers. Incidence of hydraulic malfunctions on the DC-8 is not substantially higher than on other jet transports, the FAA has said (AW Oct. 2, p. 43).

As if to prove this statement, a Western Airlines Boeing 720B on Oct. 2 made an emergency hydraulics-out landing at Edwards AFB, Calif., on a flight from Mexico City. In performing a prelanding check during descent over San Diego, the plane's pilot noted a loss of normal system hydraulic pressure. Aboard were 68 passengers and a crew of seven.

Although the aircraft still had functioning emergency systems with which to provide brakes, gear lowering the flap operation, the pilot elected to land at Edwards where the 15,000-ft. runway is backstopped by eight miles of hard, dry lake-bed. The landing proved to be uneventful.

Emergency Airstrip

But it brought to three the number of commercial jets that have used the Edwards airstrip under emergency conditions in recent months. Following the Denver crash of a United Air Lines DC-8 (AW July 17, p. 45), the commander of the Air Force flight test center informed all airlines operating jets in the area that the crash and rescue facilities of the base would be made available to prevent possible loss of life and equipment.

In addition to the Western 720B, a United DC-8 inbound from Hawaii and a United DC-8 en route to San Francisco were landed at Edwards after their pilots encountered hydraulic malfunctions.

To round out the week's jet hydraulic incidents, the pilot of a Braniff Airways Boeing 707 made a precautionary landing at Carswell AFB, Ft. Worth, Tex., and reported a malfunctioning hydraulic system. The flight had departed San Antonio on Oct. 3 but the pilot elected to land at Carswell because of its longer runways.

Another precautionary landing was made by an American Airlines pilot who found he could not retract his main landing gear fully after takeoff from Chicago's O'Hare International Airport on Oct. 4.

BRIEFING

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ALASKA offers an amazing variety of vacation possibilities — ranging from watching seals to panning for gold.

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For example, travelers actually pan for gold north of the Arctic Circle on **Wien Alaska's** "Polar Sea" tour. **Cordova Airlines** also fly modern day gold seekers to the "Klondike" on their Dawson City Sourdough Tours. And amateur naturalists can watch the annual seal migration first-hand—if they get to the Pribilofs via **Reeve Aleutian Airlines** during July and August.

Local carriers test downtown air service

Businessmen in a hurry may soon be able to take-off and land almost outside their downtown offices—if experiments now underway by several local carriers prove out.

Allegheny Airlines kicked off its experiment with an application to the CAB for scheduled helicopter service in the Washington-Baltimore area. Allegheny plans take-off and landing points in downtown Washington and at four local airports.

Lake Central Airlines is currently testing the Vertol 107 (Vertical Take-Off and Landing Aircraft) in both intra-city and downtown to downtown flights. Cities getting the benefit of this experiment are: Washington, Pittsburgh, Cleveland, Detroit, Toledo, Dayton, Indianapolis, Lafayette and Chicago.

Ellis Air Lines in Alaska already offers its own kind of downtown to downtown air service. Ellis sidestepped the problem of lack of airfields by landing passengers on the water right in front of their destinations.

VERTOL 107, built by Vertol Division, Boeing Co., carries 25 passengers, or 3½ tons of freight, at 155 mph. cruising speed.

Switch to air freight enables one firm to scrap warehousing . . . save $360,000 a year

Local carrier freight service makes "all the way by air" delivery possible. Air freight may be stirring up a quiet revolution in warehousing. An indication is the recent move by one of the nation's biggest electronics firms to scrap its entire warehouse system in favor of a single central supply depot — shipping 100% by air. • Results are eye-opening. Inventory is down $2 million. Operating expenses slashed by $360,000 a year. Best of all — distributors can expect delivery within 48 hours after placing orders. • Fast, efficient local airline freight service makes this "all the way by air" delivery possible. Last year, local carriers flew a whopping 5½ million tons of cargo in and out of 564 cities—a tonnage increase of 200% over 1950. • Local service airlines are now girding for an even bigger expansion in the 60's. New Convairs just bought by **Trans-Texas Airways,** for example, will *triple* the cargo-carrying capacity of just one line.

HUGE ALL-CARGO PLANES boost air freight efficiency and economy. General Dynamics all cargo CANADAIR 44, shown here, flies 65,000 lbs. at 400 mph. Unique hinged tail permits fast "straight-in" loading.

Information on how local airlines contribute to America's business growth . . . prepared by Texaco Inc., Aviation Sales Department, 135 East 42nd Street, New York 17, New York.

ROSTER OF LOCAL SERVICE AIRLINES: (Domestic) Allegheny • Bonanza • Central • Frontier • Lake Central • Mohawk • North Central • Ozark • Pacific • Piedmont • Southern • Trans-Texas • West Coast • (Intra-Hawaiian) Aloha • (Intra-Alaska) Alaska • Alaska Coastal • Cordova • Ellis • Northern Consolidated • Reeve Aleutian • Wien • (International) Caribair.

British-Run School Trains Airline Pilots

Hamble—Twin-engine training will start soon for the first class of cadets at Hamble College of Air Training, a school for potential airline captains sponsored by the British government.

The students headed for training in Piper Apache twins all will be absorbed by British Overseas Airways Corp. as first officers upon graduation. Second batch of cadets, who will join British European Airways, has just started training in de Havilland Chipmunks.

In less than a year since its inception the college has recruited 41 cadets, all of whom faced exhaustive interviews and tests, taken delivery of six of nine Apaches specially modified for the job, and started a new recruiting drive aimed at an enrollment of 200 cadets.

At the moment, the college philosophy is to supply the two state-owned airlines with pilots who will be in their early 20s upon entering line service and who can become captains in 10 years time. However, as the college grows, pilots also will be supplied to the independent airlines and possible Commonwealth carriers, according to officials.

Need for such a training establishment became apparent about a year ago when the two airlines found their traditional source of pilots—the Royal Air Force and the Fleet Air Arm—drying up with reductions in numbers of military aircraft and more short-term commissions.

Service Life

This is still an important source, but pilots leaving the service usually have 12 years of service time behind them, placing them in their 30s and, of necessity, cutting their airline time toward retirement drastically. Also, the costs of an air transport rating certificate must be borne by the applicant and this has discouraged many from attempting an airline career after discharge.

To fill this gap, BOAC and BEA have joined with the Ministry of Aviation to develop a school tailored to air transport requirements as a matter of public necessity.

Principal of the college is retired Air Vice Marshal E. C. Bates, an Australian who served with RAF Bomber Command from 1943 to 1945 and later became Air Ministry Director of Intelligence.

Since donning his civil service hat, Bates has vied with his former colleagues in recruiting students for the college. The Royal Air Force currently is engaged in an intensive campaign to swell its ranks, and Bates is after applicants in the same age bracket.

Bates contends that the college standards must be higher in view of the specialized nature of transport flying, and its vast responsibilities of command and decision. He and his staff, at the last go-around, started with 600 applications, cut them to 200 and finally selected 41 for the initial year of training.

One obvious reason for the extensive cut is that the first class will be closely watched—not only by the two airlines, but by the Ministry and services—and Bates contends that cadets must be of the highest caliber. Only three have washed out so far.

Flying training consists of 150 hr. in the two-place Chipmunks before moving into the Apaches for 75 hr. of advanced training. In addition, the cadets receive 80 hr. in Link trainers, and another 60 hr. in two jet and turboprop transport simulators specially designed for the college by General Precision Systems, Ltd.

Initial Test Phase

Like any other air training facility, the Hamble flight instruction staff, headed by G. C. Webb, chief flying instructor, prefers its students to have no previous training. Part of the initial testing phase is 5 hr. of dual to check on basic aptitude. In the current class, about half have had some previous time, mostly in club flying.

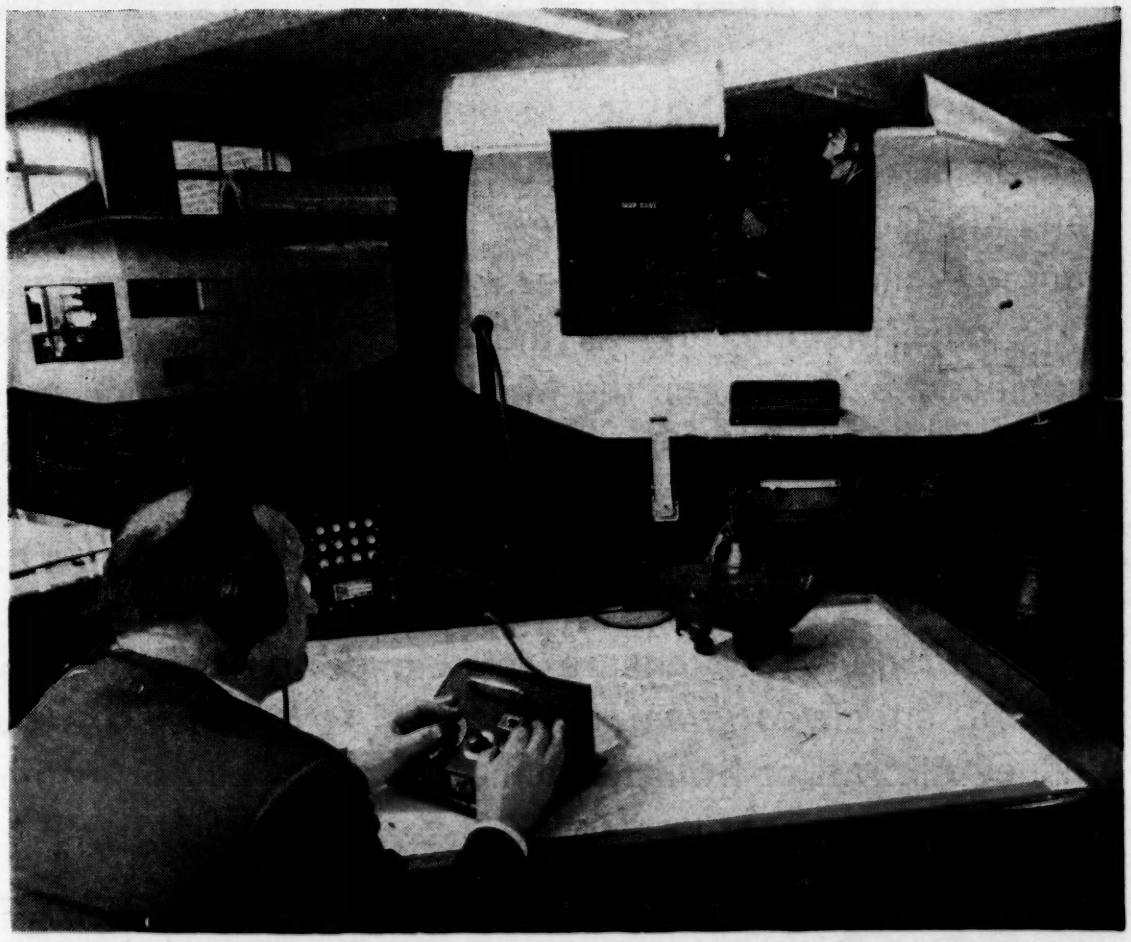
Heavy stress has been laid on the Link and simulator sessions, since actual flight training time in a Boeing 707 in airline service is about $3,000 per hour, and the college puts heavy emphasis on its cadets having a firm foundation in instrument procedures long before they don airline uniforms.

Apache Modification

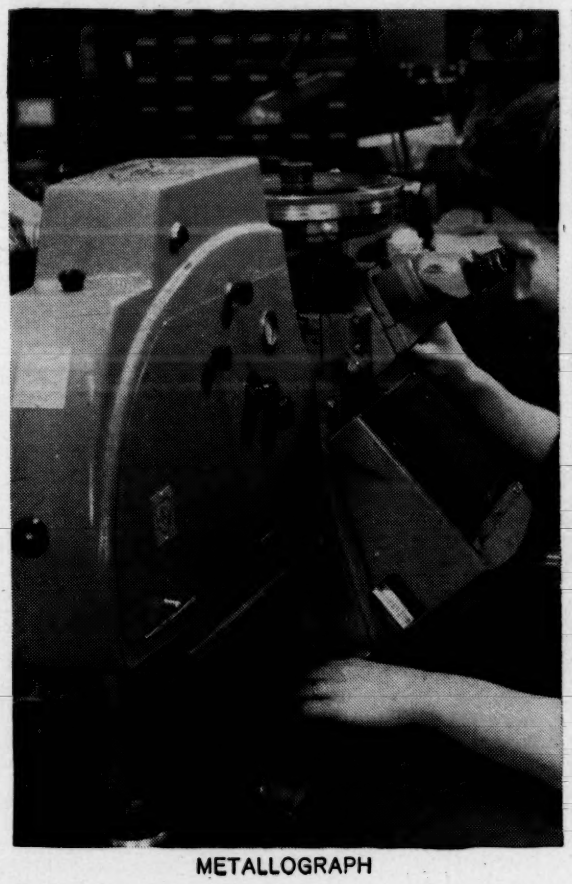
At present, Webb's nine-instructor staff, is working on buildup of Apache time while continuing the Chipmunk training program. Webb said the Apache was selected after evaluation of several U. S. twins, with a requirement for various modifications on the production line. Planes were purchased through Wing Cdr. T. A. Vigors, managing director of Vigors Aviation, the Piper distributor at Kidlington.

Major modification is installation of feathering pumps on both engines, to allow unfeathering in flight for training purposes, Webb noted. Another is relocation of the pitch trim from the cabin roof to the floor between the pilots; it now is a fore-aft wheel instead of a crank, and Webb says Piper is considering making this modification standard on its Apache line.

Apaches all have a complete Collins radio package, since most of the 75 hr. of twin-engine training will be spent on Red One airways studying procedures, flight planning, and ILS and ADF letdowns and approaches. Hamble has no runways and only an ADF homer for the grass field, so airways and nearby



CADETS AT HAMBLE fly Link trainers for 80 hr. as part of the school's ground training program. The cadets also receive 60 hr. in turboprop and turbojet transport simulators, in addition to 225 hr. of flight time in both single and multi-engine aircraft.



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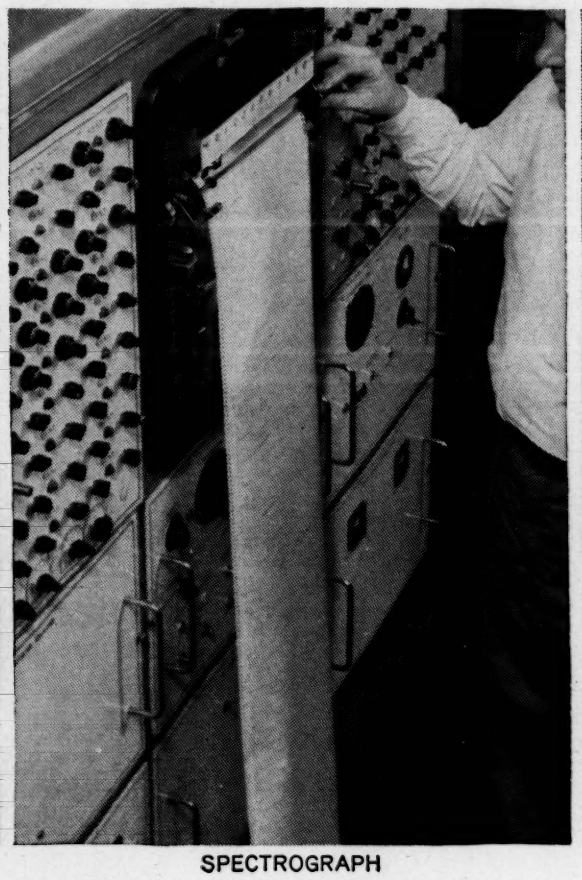

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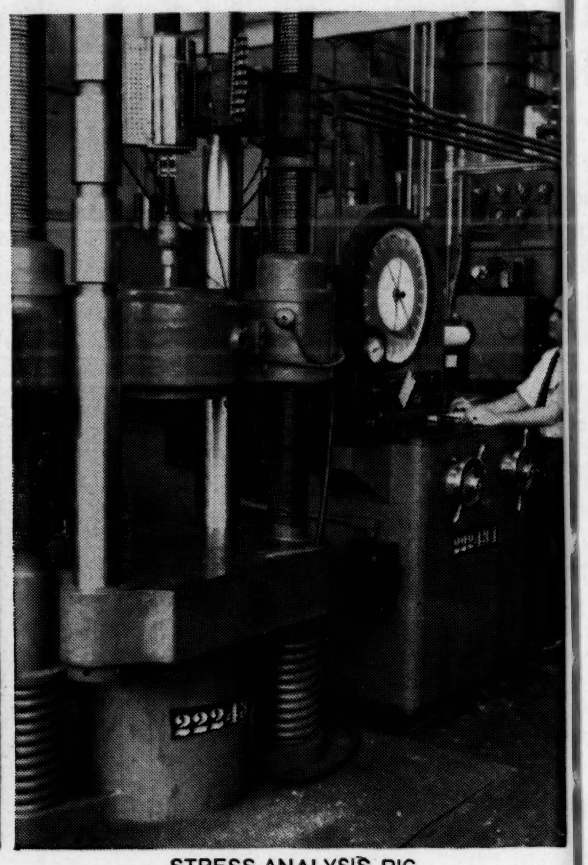

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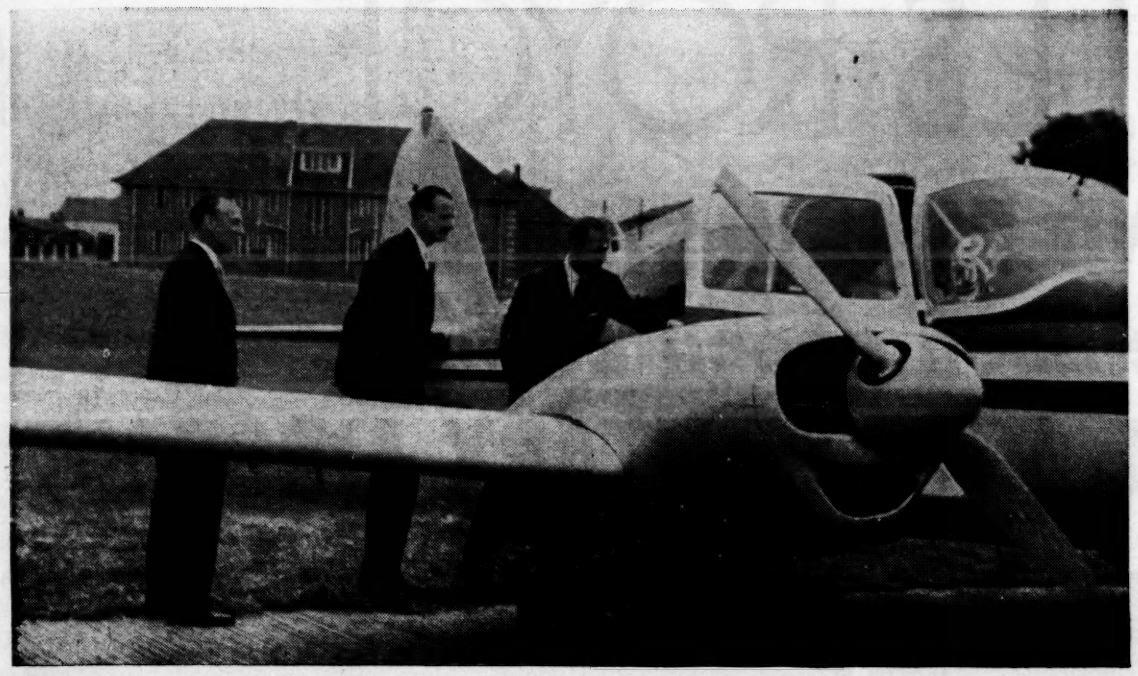

FIRST PIPER APACHE received by Hamble is inspected by school officials and the Duke of Edinburgh. Apache has been modified to have feathering pumps on propellers and floor-mounted pitch trim. Below, a student taxis a Chipmunk basic trainer at Hamble's grass field.

commercial fields will be used for the instrument training.

Collins package also includes a VOR and marker beacon unit, plus a 360-channel transceiver for the main communications needs. Cadets will be allowed to select either a headset or use their overhead speaker; the entire program is directed at as close simulation of the airline pilot's needs as possible. For example, cadets get only a touch of aerobatic training in the Chipmunks and that is only to teach them recovery from unusual attitudes, Webb said.

The flight program will be intensive, up to 60 hr. per month for each student. It is backed up by a comprehensive ground school which also includes a course in liberal arts because the college considers that its graduates, as airline captains, will in a sense become "ambassadors" for Great Britain.

The college itself is the former Air Training Services facility, purchased by the Ministry and the airlines from Hawker Siddeley. Ministry has allocated about $530,000 for college operations in 1961 and 1962, which includes a grant of about $3,000 toward student training, with the remainder of a total training cost per student of about $10,000 borne by the two state-owned airlines. Each student pays a fee of $1,500, although this sum usually is recaptured through scholarship awards.

Upon reporting to their particular airlines, the student is checked out as first officer, but, under present plans, may spend more than a year serving as a third pilot, navigator, or combination of both. British regulations call for a minimum of 200 route hours as a navigator before a certificate is awarded and after this period, the new officer would be assigned duties in the right seat. He can expect to make $2,800 per year after graduation. British airline captains now earn about $14,000 per year, and retain about half that figure as pension upon their retirement.

BOAC Sees Loss From Strike, Traffic Slump

London—British Overseas Airways Corp.'s appeal against allowing Cunard Eagle Airways to operate on the North Atlantic ended with BOAC predicting heavy losses for this financial year.

The airline already has incurred a $6-million loss due to the strike of maintenance men at London Airport (AW July 24, p. 43), according to Sir Basil Smallpeice, managing director. He also claimed the airline has lost $1.8 million on the North Atlantic this summer due to a slump in traffic which was put by BOAC at 11% (AW Oct. 2, p. 42).

BOAC has announced plans to cut seat capacity about 7% next spring on its routes between New York, Washington, Boston and the U. K.

In its answer, Cunard Eagle stressed that two British airlines stimulate additional traffic, primarily through the independent airlines' tieup with Cunard Steamship sales offices. Referring to international agreements, Cunard Eagle said the appeal had "Alice in Wonderland" overtones in that the Air Transport Licensing Board had conferred with Minister of Aviation Peter Thorneycroft on the bilaterals before granting permission to fly the route in parallel with BOAC.

Subsidy Cut Ordered For Central Airlines

Washington—Central Airlines' subsidy would be reduced about $500,000 annually under a show-cause order issued by the Civil Aeronautics Board.

Calculation of the airline's temporary mail rate payments under the new class mail rate formula resulted in a subsidy overpayment of nearly $200,000 during a recent four-month period, the CAB said. Operating results of the airline between Mar. 13 and July 31 indicate that Central should be provided annual subsidy payments totaling $4,009,349 for the one-year period ending Mar. 13, 1962, the Board said.

The order contended that Central's present subsidy is higher than necessary because the airline has experienced lower costs and higher revenues than anticipated under expanded operations which include new service to many points awarded in the Kansas-Oklahoma Local Service Case.

As applied to Central, the new rate will cover only the airline's breakeven need and interest expense. A final rate, when determined, will also provide Central with a return on its investment and provision for taxes. The Board noted that the show-cause order is designed to prevent future overpayments.

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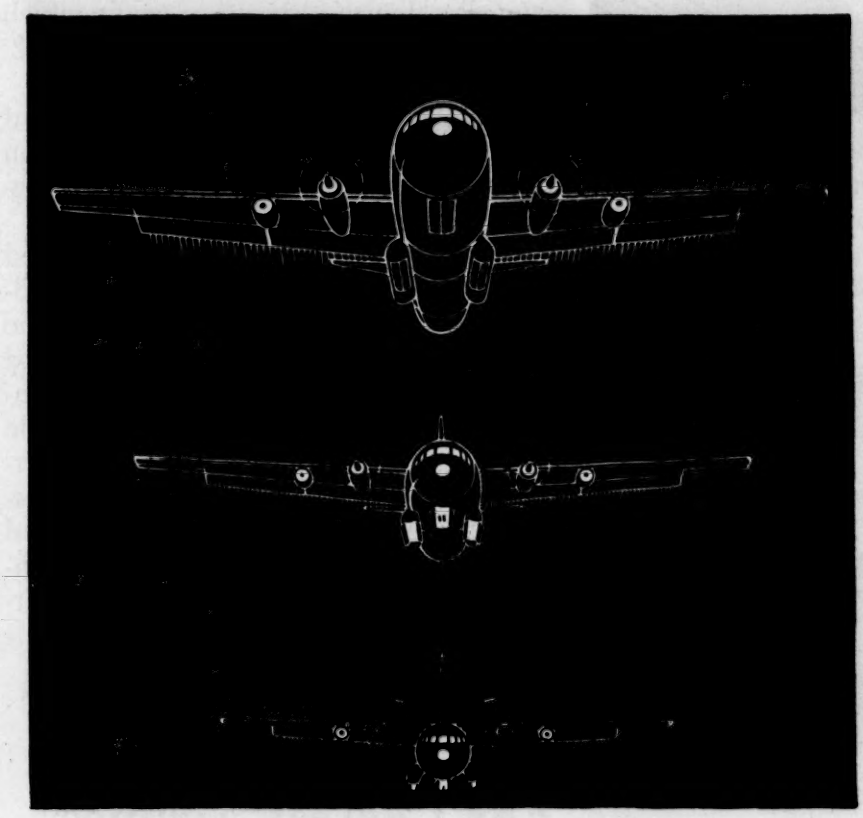

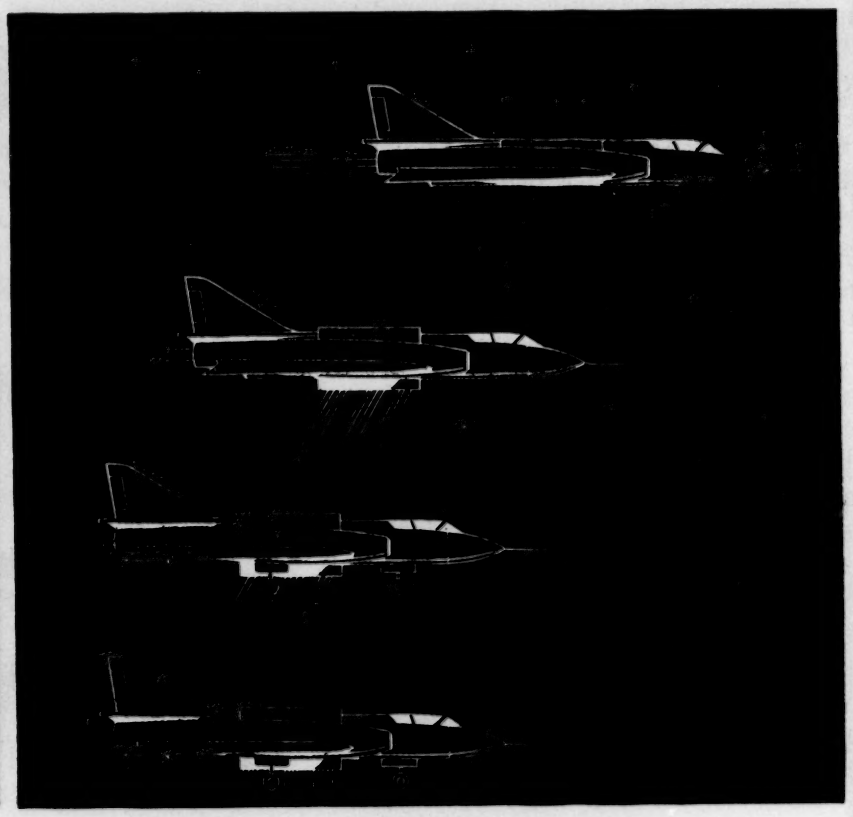

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Braniff Losses Bring Request for Subsidy

Washington—Braniff Airways has asked Civil Aeronautics Board to approve a $3.1-million annual subsidy for its Latin American operations—exclusive of its Mexican route—after incurring losses for each year since it stopped receiving subsidy in 1957.

Braniff's application underscores the plight of U. S. Latin American carriers. Two, Pan American Airways and Panagra, already have applications for subsidy pending before the Board. Pan American, which lost $5.1 million on its Latin American operations during 1960, has a subsidy application before the Board for operations from Oct. 1, 1956 through Calendar 1958. Panagra wants subsidy for operations from Oct. 3, 1958 through the present.

Prospects appear slim for quick Board action on Braniff's request, but any action taken is bound to indicate future Board policy toward U. S. international carriers suffering from foreign competition.

Braniff said that in 1957, when it went on a temporary non-subsidy mail rate, combined domestic and international revenues showed promise of future subsidy-free operations. However, both revenues declined and the airline said that it does not expect domestic profits sufficient to offset its international needs.

Decline in Latin American revenues was blamed chiefly on increasing foreign competition—19 carriers in the Latin American market this year—and certain regional restrictions. Braniff's traffic to and from Buenos Aires is subject to capacity limitations by the Argentine government, while exchange rates have allowed foreign carriers to offer price inducements which U. S. carriers cannot match.

U. S. Latin American carriers are currently involved in a South American route proceeding ordered by CAB (AW Aug. 14, p. 47) that will decide which two of four carriers now serving this market will be allowed to continue to do so. CAB hopes that the surviving carriers can operate without subsidy by eliminating duplicate routes and achieving a competitive balance.

Braniff based its subsidy needs on losses incurred by its Latin American operations during the 12 months ended last June 30. Losses for that period were over $1.1 million before taxes. Projecting this figure for 1962, Braniff figures it needs $3.1 million subsidy or 97.1 cents per plane mile based on 3,194,000 revenue plane miles flown during Fiscal 1961.

The subsidy would be in addition to the $330,000 annual Latin American mail pay that Braniff receives.

SAS, Swissair Seek New 990 Contracts

Zurich—New contracts for delivery and subsequent modifications to the nine Convair 990 jet transports on order by Swissair and Scandinavian Airlines System are scheduled to be negotiated sometime this month at meetings here between representatives of the manufacturer and the two European carriers. Initial sessions may get under way late this week.

Substance of the contracts is expected to closely follow the lines of the revived pact recently negotiated between American Airlines and Convair (see p. 48). Renegotiations were agreed upon when it was found that the initial aircraft would fail to meet their guaranteed speed ranges (AW Sept. 18, p. 40). Convair is completing modification studies to boost the plane's present cruising speed of approximately 584 mph. to 620 mph.

A Swissair spokesman said last week that his airline wants changes in the original 1959 contract that will "take into consideration" the modifications and the fact that the first aircraft will not meet their design speeds.

Swissair, which at one time had hoped to receive its 990s in time to place them on its Far Eastern routes during the 1961 summer season, now plans to take delivery of its first unmodified aircraft by the middle of November, a second in December, and begin scheduled service by the end of January. The fourth aircraft will be delivered with the modifications already incorporated, and the first three will then be returned to Convair San Diego on a rotational basis for the necessary fixes.

The 880s leased by the Swiss carrier from Convair to help meet the jet competition on its Far Eastern service pending the arrival of the 990s are slated to be retained at least until the end of March.

Of the seven 990s on order by Swissair, two will be leased to SAS, which also is purchasing another two directly from Convair.

Air Union Nations' Agreement Advances

Four European nations involved in the proposed Air Union—France, Belgium, Italy and West Germany—are studying proposals whereby the governments themselves hold membership in the Union and designate their national carriers for participation.

Presumably, these carriers would be those that worked out the draft convention last spring—Air France, Sabena, Alitalia and Lufthansa. (KLM dropped the Air Union plan in May, 1959, over disagreement on quota aspects.)

Although the four carriers agreed last spring to a format for the Union (AW June 5, p. 47), further action has been stalled waiting for individual government study and approval. Final signature of the governments concerned—which would permit Air Union to begin operating—is not expected before next spring. Also, absence of West German government presently is holding up further Air Union talks.

France's TAI, UAT To Merge Operations

Paris—Two of France's private airlines have agreed to merge their operations to better meet the problems of jet flights.

The carriers involved are Union Aeromaritime de Transport (UAT) and Transports Aeriens Intercontinentaux (TAI). It is expected that completion of the merger will take two years. During much of this transitional period both carriers will continue to operate under their individual colors.

UAT carried 201,000 passengers and 2,700 metric tons of freight last year. Its network extends mainly from Paris to Johannesburg with stops in southern France, northern and western Africa. TAI carried 86,500 passengers and 13,555 tons of freight in 1960. Its main route—one of the world's longest—runs from Paris through the Middle and Far East, Australia, Tahiti, Honolulu and terminates in Los Angeles.

While a complete merger is expected to take two years, TAI immediately will double its capital and absorb the bulk of UAT's capital.

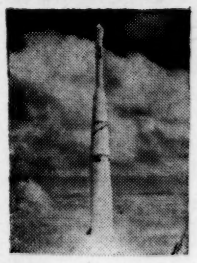
Firm Seeks Extensive Helicopter Authority

Washington—Eastern Copter Service, a Massachusetts firm, has asked Civil Aeronautics Board for authority to operate scheduled, non-scheduled, passenger, property and mail service with helicopters in seven northeastern states.

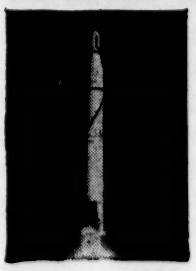
The carrier also has asked for authority to operate between downtown areas of five New England cities and any points within a 50-mi. radius.

Eastern Copter says it has five Omega Aircraft Corp. Model BS-12D1 helicopters on order that can be delivered during this month, November and December. The firm says it has a tentative order to acquire five used Boeing Vertol 44B helicopters from Boeing after New York Airways trades them in on Vertol 107s. Eastern Copter says it expects to have 15 helicopters by fall 1962.

DISCOVERER SERIES Position gyros to aid vital satellite recovery programs have been developed and produced for this series by General Precision.



EXPLORER SERIES Over 20 General Precision components have assisted in the launching of these satellites.



MIDAS General Precision has developed and is now producing control moment gyros to stabilize MIDAS satellite with reference to earth when satellite is in orbit.

The major systems interpreted here are testimonials to General Precision's experience in space. The four divisions of General Precision, Inc., are represented by some system, subsystem or component on nearly every satellite, space vehicle, missile and rocket now in operation or development.

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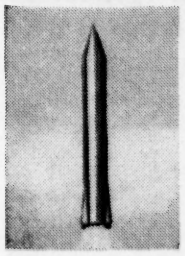
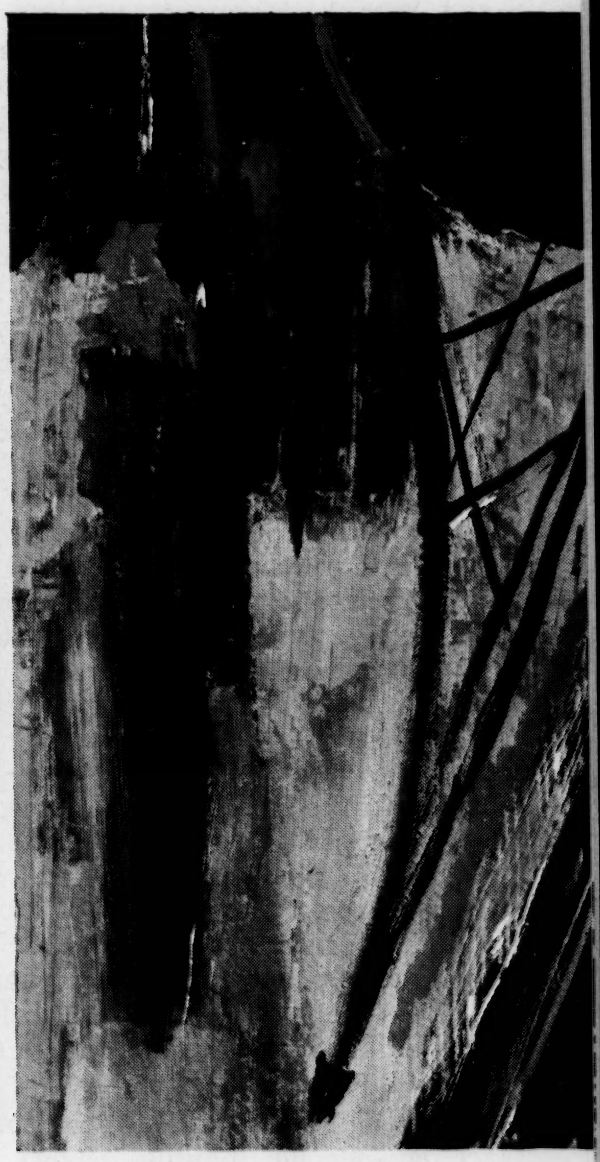
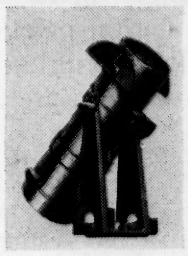
GENERAL PRECISION AND SPACE

CENTAUR A 32-lb. digital computer with a displacement of less than 0.6 cubic foot has been developed and is now being produced by General Precision for this space vehicle's guidance system.





VENUS STUDY A balloon-borne optical astro-tracker developed and produced by General Precision is being used in a series of explorations to photograph Venus for the first time from outside the earth's atmosphere.



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AIRLINE OBSERVER

▶ Wall Street is speculating on the merits of a Braniff-Northeast merger which reportedly has been discussed between the two parties.

▶ Agreement between American Airlines and General Dynamics for delivery of 15 Convair 990 turbojet transports (AW Sept. 25, p. 354) calls for American to lease the unmodified aircraft with the option, in effect, of returning them in February, 1963, if not satisfied with the fixes. American has numerous other alternatives—limited to some degree by expiration dates—including purchase, presumably at more favorable terms than originally called for. Progress payments for the airplanes are being banked under American's control and will not be turned over to General Dynamics unless terms of the agreement are met.

▶ Hughes Tool Co. still intends to purchase the 13 Convair 990s it has on order, sources close to the project believe. Hughes reportedly had a good legal position to drop the orders, but has shown no indication of doing so despite TWA's decision to buy Boeing 707s rather than the Hughes' 990s.

▶ Watch for the White House to make public a letter from Sen. A. S. Mike Monroney (D.-Okla.), chairman of the Senate's aviation subcommittee, urging President Kennedy to assign a presidential board to investigate the 16-month-old Southern Airways pilot strike. Sent without any fanfare, Sen. Monroney's request was endorsed by at least one other Senator representing a state served by the airline. Appointment of a presidential board to probe the Southern deadlock has been a major goal of Air Line Pilots Assn. (AW July 17, p. 49).

▶ Airlines have been asked by the Kennedy Administration to submit views as to whether the U. S. should withdraw from or seek to modify the Warsaw Convention of 1929 which limits liability for damage in international air accidents to $8,300 for each passenger. Aviation lawyers and bar associations have received similar requests. Feeling is growing that liability ceiling should be raised or removed altogether. Opinions are due to be filed with the State Department before Nov. 15.

▶ Air traffic controllers last week were viewing with suspicion the retirement section of the Federal Aviation Service bill now before Congress (AW Oct. 2, p. 46). Draft legislation submitted by Federal Aviation Agency states that only with the consent of the FAA Administrator may controllers with 20 years of service retire at age 50, but that the Administrator could retire such employes involuntarily if he chose to do so in the interest of the FAS or the Agency. Air Traffic Control Assn., however, has not specifically objected to this section of the bill.

▶ Civil Aeronautics Board has decided to continue its requirement that airlines file monthly reports covering on-time performance of schedule operations. Reports will be confined to performance between each of the 100 top-ranking station pairs, omitting those less than 200 mi. apart. Helicopter carriers, all-cargo airlines, supplemental air carriers and intra-Hawaiian and intra-Alaskan services are exempted.

▶ Flag carriers in Central America are considering the formation of an airline syndicate in order to cut costs and increase revenues. Under the plan, airlines of the five Central American nations would integrate to create a single pooling operation.

▶ Federal Aviation Agency has set a deadline of Oct. 31 for public airport operators to submit requests for federal aid. Under the Federal Airport Act, FAA is authorized to allocate up to $75 million for airport aid during Fiscal 1962.

▶ Trans World Airlines has been granted a 200-hr. overhaul time extension to 2,000 hr. on the Pratt & Whitney JT-4 turbojet engines which power its Boeing 707 Intercontinental transports.

SHORTLINES

▶ **Airborne television** transmitters operating from a DC-6 circling over central Indiana are transmitting instructions to more than one million students in a six-state area in the Midwest, as part of a series of educational programs that will run until late May, 1962. The programs are sponsored by Ford Foundation and private industry. The TV equipment is manned by Westinghouse crews and transmissions are from tapes.

▶ **American Airlines** will begin a late-evening nonstop Boeing 707 flight from New York to San Francisco on Oct. 29. Flight will leave Idlewild 11:30 p.m. and arrive San Francisco 2:10 a.m. (local times) every day except Saturday. Meals will be patterned after New York's "21 Club."

▶ **Blanket exemption** proposal allowing foreign air carriers to conduct off-route passenger charters (AW May 8, p. 39) subject to certain limitations, will go into a formal hearing. Civil Aeronautics Board has rejected petitions by U. S. and foreign carriers to dismiss or expand the proceeding.

▶ **Braniff Airways** credit cards – for domestic flights only—are now available to commissioned officers in the U. S. armed forces without usual credit checks.

▶ **Eastern Air Lines** reports independent research shows that the average executive travels 30,000 miles a year on about 19 trips that keep him away from home and office for 54 days.

▶ **First of three** Armstrong Whitworth Argosy 650 turboprop airfreighters ordered by British European Airways made its initial flight late last month. The aircraft will be phased into BEA's cargo operations in November, with the other two scheduled for delivery in February.

▶ **Israel and France** have concluded talks expected to lead to increased activities of El Al and Air France between the two countries. El Al now operates six flights to Paris weekly and Air France operates six flights to Lydda, Israel.

▶ **Sabena** will begin service to Rome and Istanbul, Turkey with Caravelle VI aircraft on Nov. 1.

▶ **Stewardesses** on American Airlines' flights have been instructed to provide passengers with World Series and college football scores in the area of departure and destination.

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ARTIST'S CONCEPTION of Lockheed C-141 shows fan engines, landing gear bulges and high, swept T-tail. Aircraft is expected to make its first flight in November or early December, 1963 after scheduled August, 1963 roll-out.

Flow of C-141 Subcontracting Under Way

By David H. Hoffman

Marietta, Ga.—Development of Lockheed's C-141, the turbofan freighter designed to bolster U. S. strategic airlift, is on schedule here as subcontracts ultimately worth more than $500 million begin to flow toward U. S.—and perhaps Canadian—manufacturers.

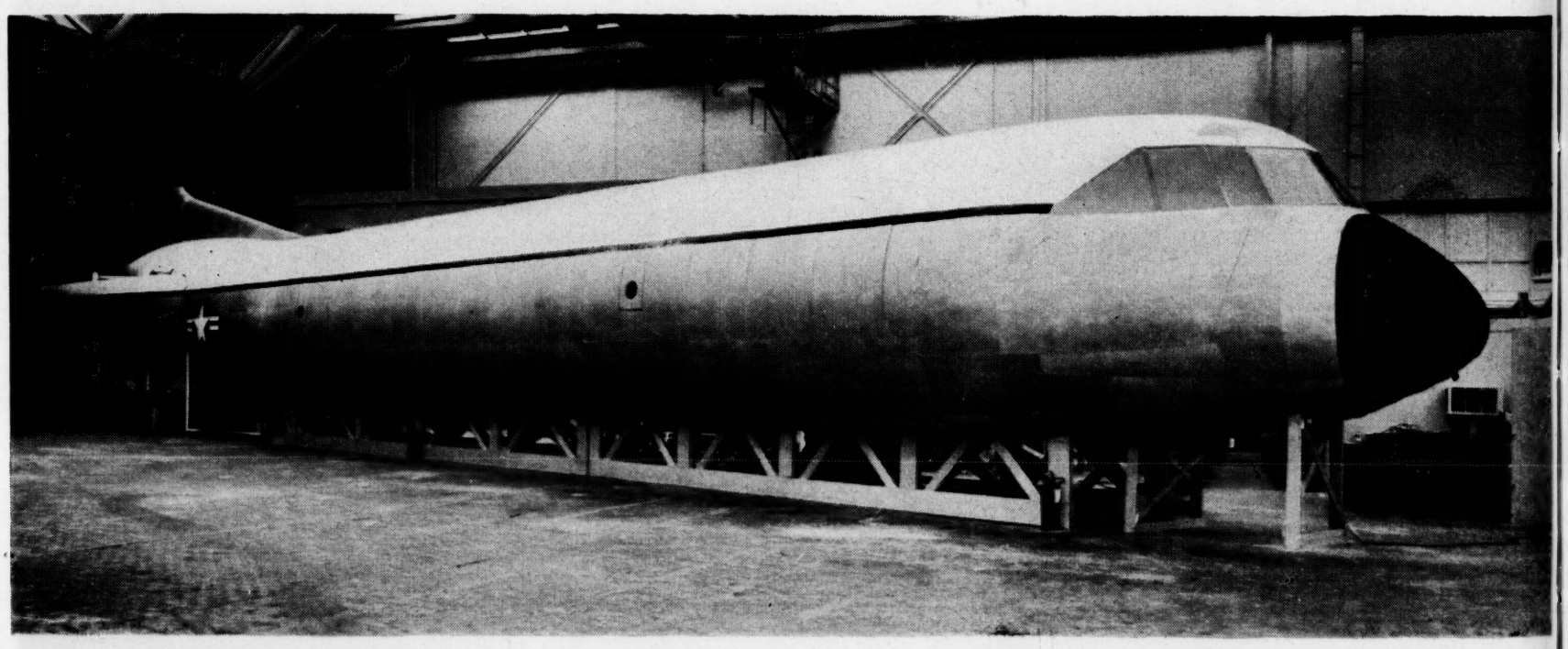
Only a letter contract from Air Force ordering five C-141s for development testing has been received by Lockheed thus far. But the company has been told to base its pricing policies on the purchase of 132 aircraft. If each sells for about $6 million as expected, Lockheed will oversee the distribution of about $1 billion in U. S. funds, all earmarked for military aircraft.

Regardless of how many C-141s it builds, Lockheed has guaranteed to subcontract at least 61% of the entire Air Force order, and this figure excludes the aircraft's engines—Pratt & Whitney TF33-P-7 (JT3D-8A) turbofans. To illustrate the vast role of subcontractors in the project, the C-141's complete empennage, pylons, nacelles, thrust reversers, wingtips, wing leading and trailing edges, flaps, ailerons, cargo floor, wing box beams and many systems all will be farmed out by Lockheed.

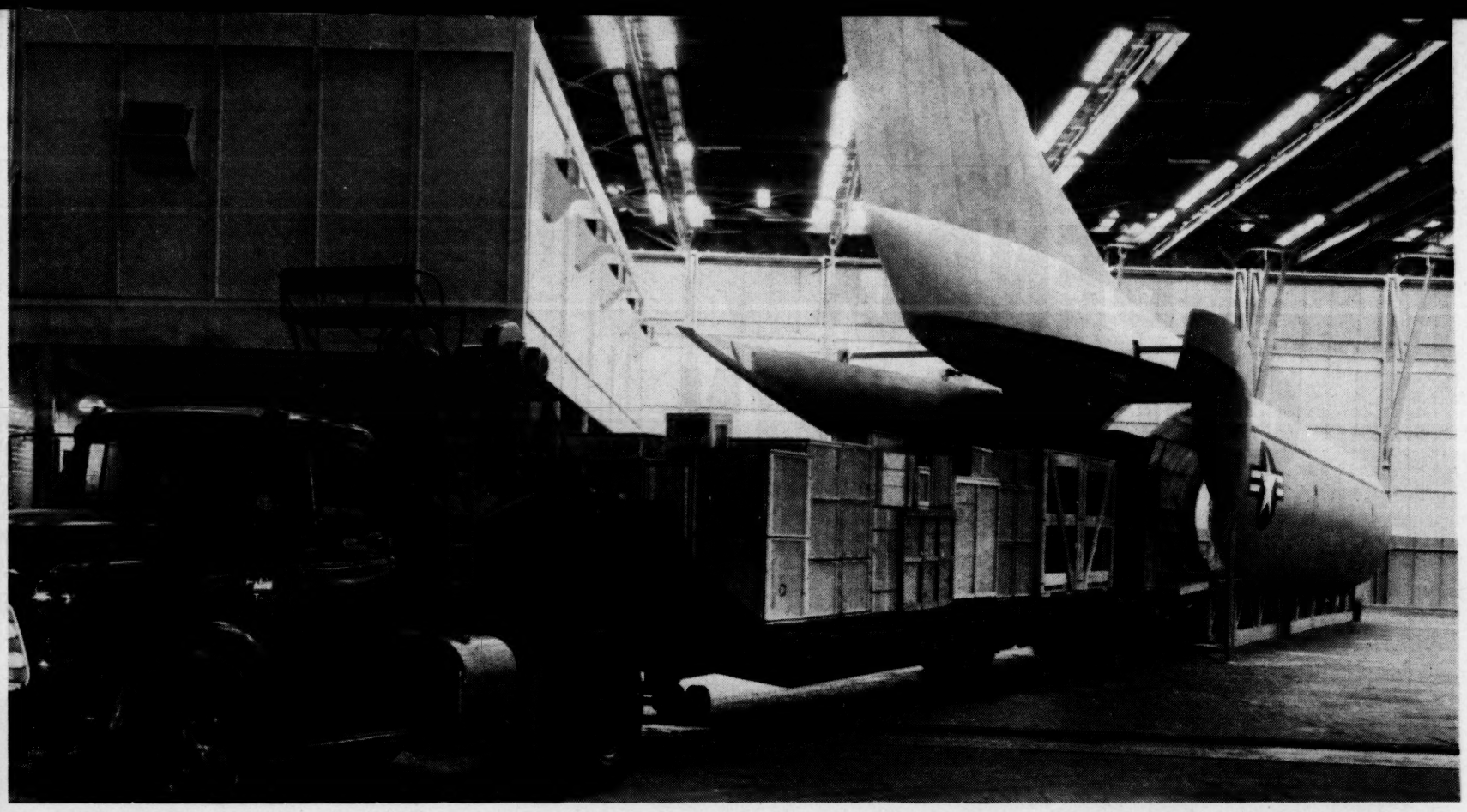
Charles S. Wagner, Lockheed Georgia Division vice president and over-all C-141 project manager, told AVIATION WEEK that this subcontracting will extend through the coming year. Deadline for signing the last subcontract, which covers the transport's rail and roller assembly, is November, 1962.

Meanwhile, Air Force Systems Command, through its Systems Program Office (SPO), is monitoring and approving Lockheed's selection of each subcontractor. Apparently for political reasons, Lockheed also has been told to consider Canadian sources of supply in contracting for C-141 components.

The C-141's contours are fixed by loft studies which define the outer lines



FUSELAGE MOCKUP for C-141 project shows state-of-the-art design concept. Petal doors at rear open outward to allow rapid loading and unloading. Mockup is full scale. Basic dimensions have been decided, but many of the subsystems still are only in early design stages.



FLATBED TRUCK demonstrates cargo backup to wooden mockup of C-141 at Lockheed's Georgia Division plant. Along the length of the cargo compartment are floor boards that invert to form a simple roller system for moving containers forward. Commercial version of the aircraft will have a lightweight cargo floor and a Lockheed-developed loading system for an empty weight saving of 1,555 lb. Petal doors of the C-141 open outward for loading on the ground or for para-dropping heavy equipment in flight.

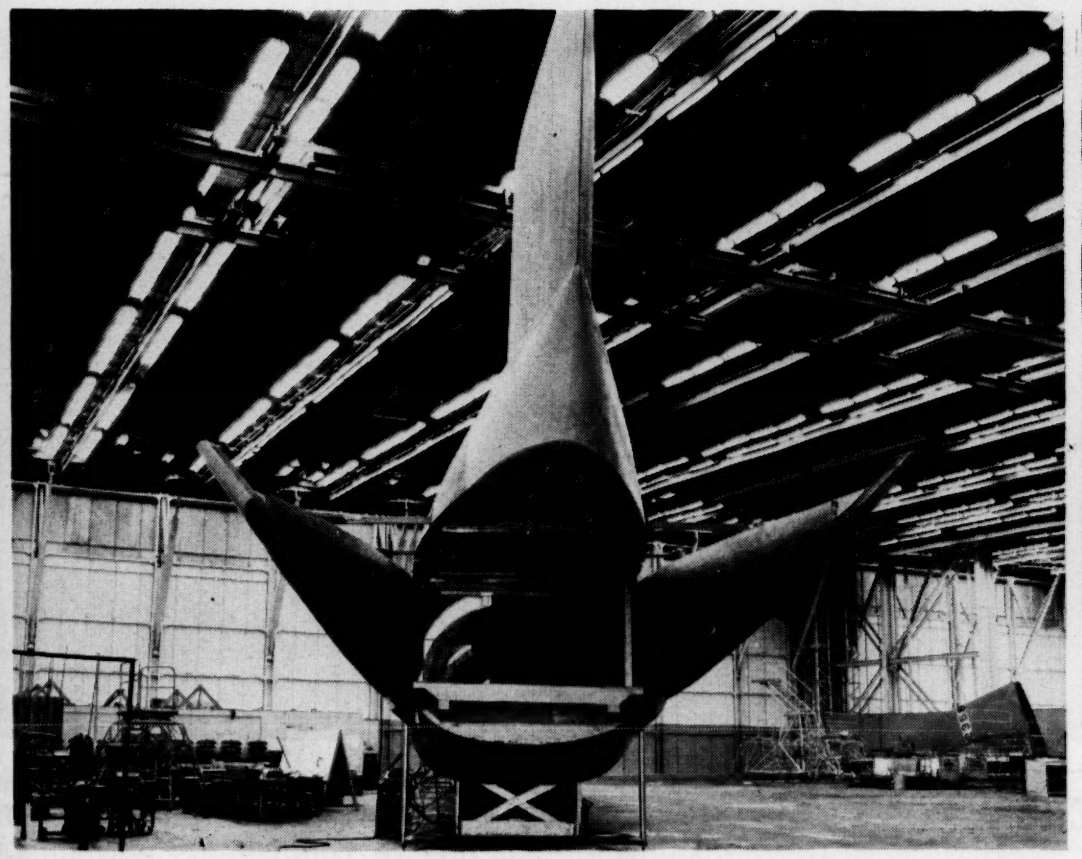
of the C-141. Although subcontractors must work within these outer contours, in many instances they will be allowed wide latitude in designing systems and components. Subcontracts for the aircraft's empennage, nose and main landing gear fall in this category, as do others.

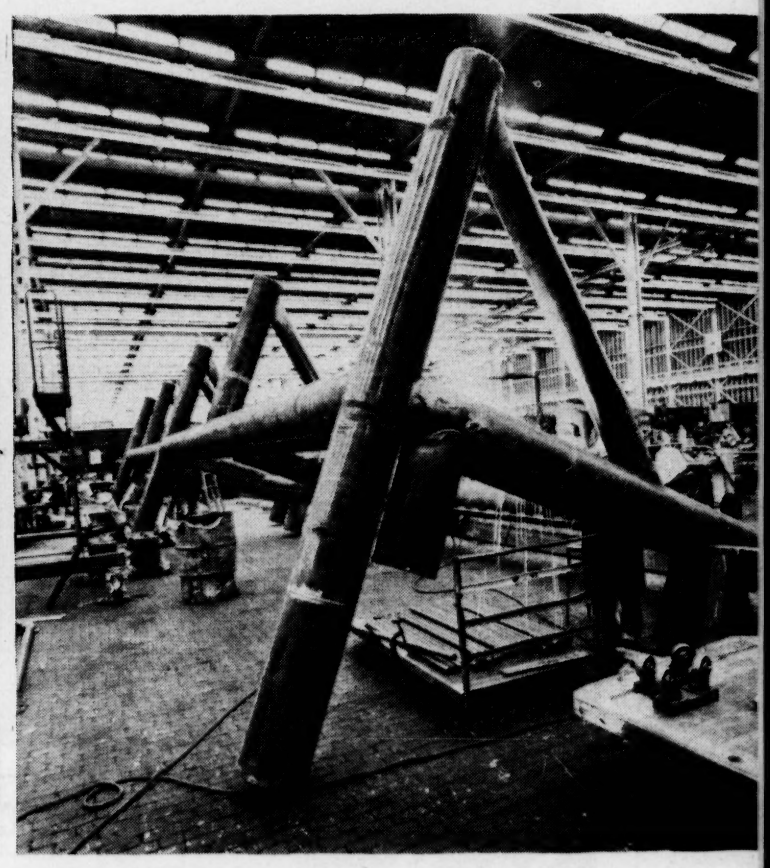
Fast pace of the C-141 project is set forth in the timetable Lockheed intends to meet. This calls for the first of the swept-wing transports to roll out in August, 1963—or less than 29 months after Lockheed received word it had been selected as prime C-141 contractor.

First flight of the Lockheed C-141 is to follow in November or early December, 1963.

If the first squadron of line C-141s joins Military Air Transport Service's fleet in June, 1965, as planned, credit can be assigned to three major factors: the full fiscal support supplied by Department of Defense and Congress; Lockheed's own reorganization of its Georgia company to reflect the project's high priority and the simple, state-of-the-art design that characterizes the C-141.

The C-141 emerged from Specific Operational Requirement 182, which assumed its final form on Aug. 15, 1960. To finance the SOR-182 design competition and to get the C-141 project rolling, $30 million was included in the Fiscal 1961 budget. This amount was more than tripled in Fiscal 1962, when Congress voted $98 million for





PETAL CARGO DOORS on the C-141 are hinged horizontally. Lower sections automatically retract as upper sections swing out to expose a cross-section of the freighter's cargo compartment. The door system is hydraulically operated. Forward of the petal doors is a pressure bulkhead shown lowered to form a truck-bed height loading ramp. It can be inclined for drive-up ramp. Basic framework of C-141 cargo floor assembly jig lies tilted on its side at Lockheed Georgia plant at right. Work is proceeding on various jigs.

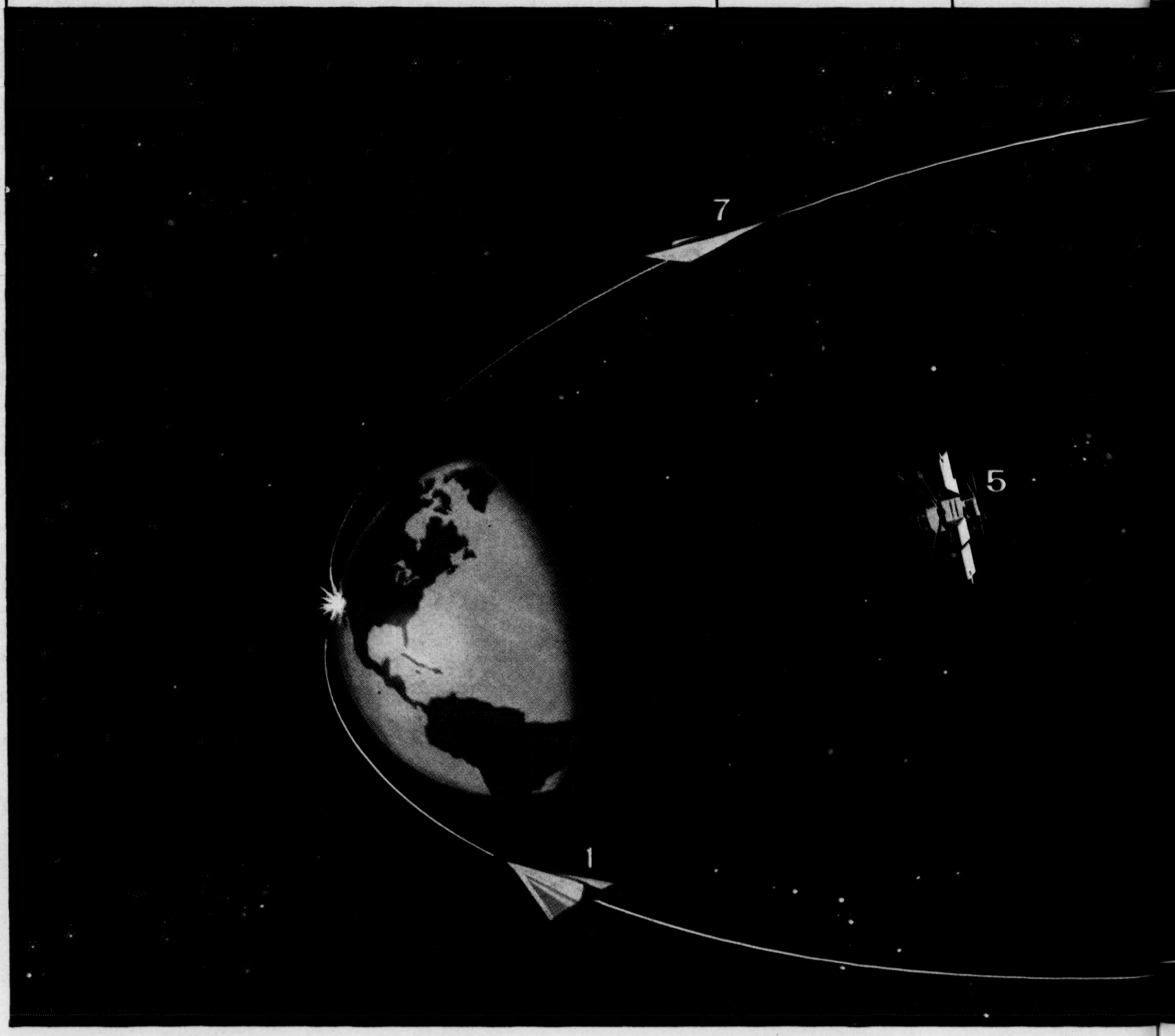
BENDIX COUNTDOWN FOR SPACE

7

PNEUMATIC CONTROLS: Hot gas equipment is being developed for space control subsystems using rotary and linear actuation, reaction jets, and pneumatic computation. A complete subsystem is now being built at E-P under USAF contract.

6

SELF-ADAPTIVE CONTRO SYSTEM: Capable of measu lng dynamic sensitivities an adjusting feedback gains stable fashion without sensi external environment. Aut matically blends control aerodynamic surfaces an reaction jets. Being develope under USAF contract.



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5

SATELLITE CONTROL AND STABILIZATION: Eclipse-Pioneer has total in-house capability for producing spacecraft attitude-control systems. In production: ADVENT reaction wheels. In development: sun-sensors and star trackers.

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STAR TRACKER SYSTEM: A system incorporating multiple star tracking heads, designed to operate without a protective dome in the environment of space; digital readout accuracy of ±5 arc seconds.

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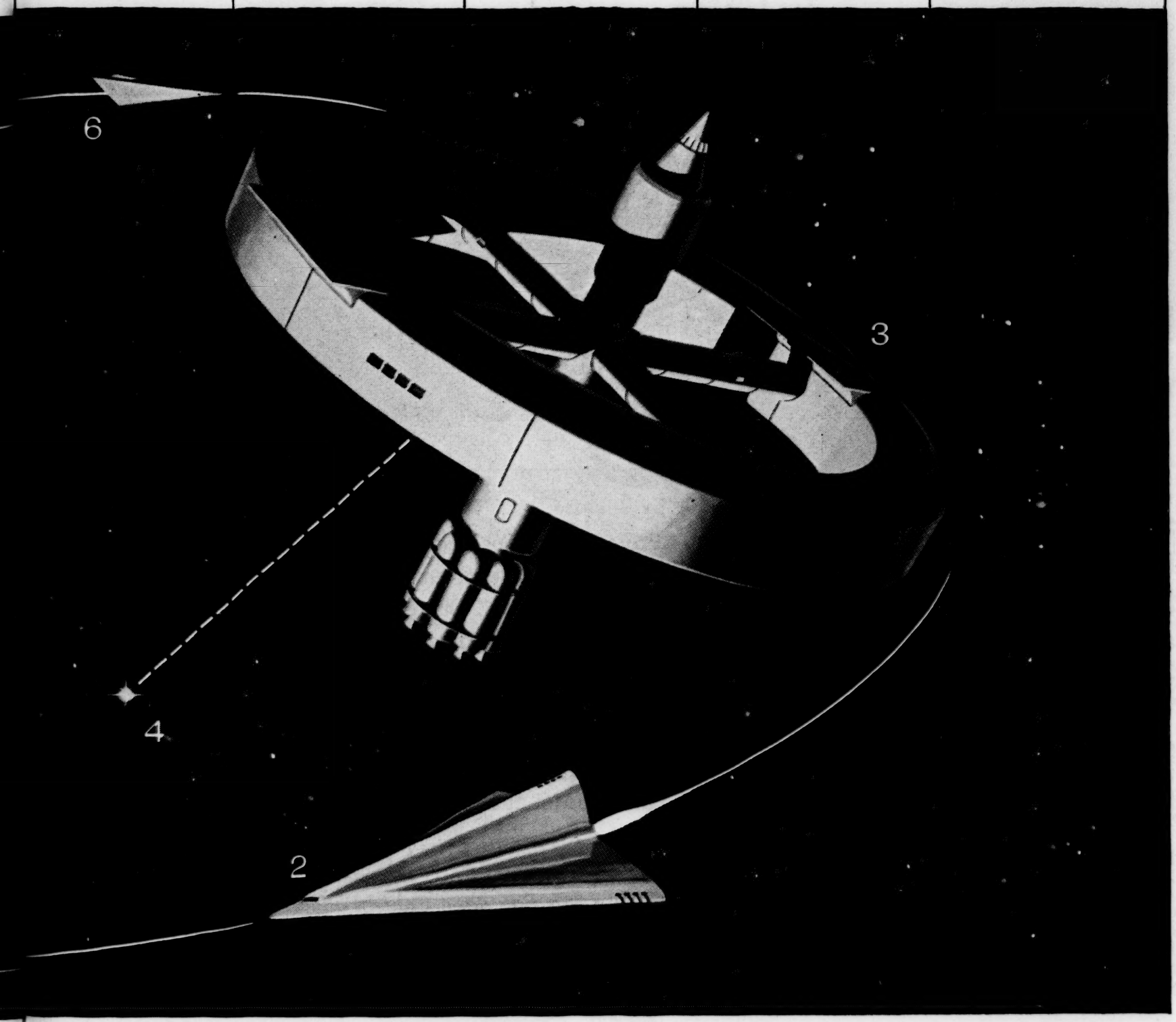
ADVANCED DISPLAYS AND CONTROLS: Development currently in progress. Human-factor display studies directed toward rendezvous, re-entry, energy-management. Electronic and optical devices will present correlated data with minimum panel space.

1

LETDOWN, APPROACH, LANDING: Safer, more reliable letdown and landing systems—such as inertially augmented flare and runway-alignment, computers, advanced instrumentation (including real-time displays)—are now being developed, flight-tested.



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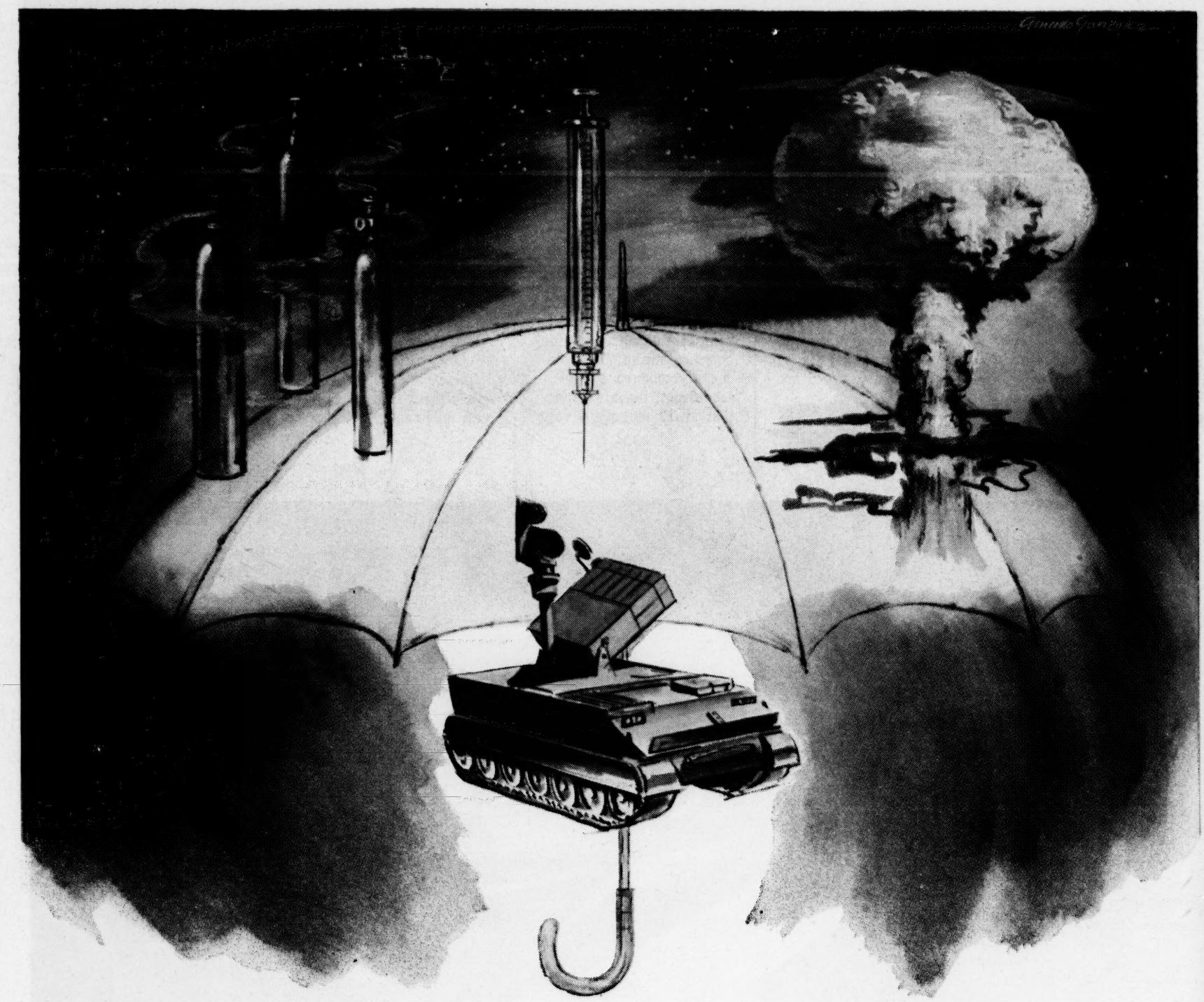

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Preliminary C-141 Performance and Specification Data

Performance

Maximum cruise	480 kt.
Long-range cruise	440 kt.
Airdrop speed	115-200 kt.
Sea level rate of climb (standard day)	3,400 fpm.
Military takeoff distance at maximum gross over 50 ft. obstacle	5,300 ft.
Military landing distance at maximum landing weight over 50 ft. obstacle	3,500 ft.
Military maximum range with 80,000 lb. payload	3,430 naut. mi.
Military payload with maximum fuel	36,280 lb.
Military range with maximum fuel and payload	5,570 naut. mi.
Military ferry range	6,560 naut. mi.
FAA takeoff field length at maximum gross	6,000 ft.
FAA landing field length at maximum gross	6,250 ft.
Civil domestic range with 82,000 lb. payload	3,450 naut. mi.
Civil domestic payload with maximum fuel	40,000 lb.

Dimensions

Length	146.2 ft.
Height	39.1 ft.
Span	160.7 ft.
Wing area	3,228 sq. ft.
Wing sweep	25 deg.

Aircraft weights

Maximum takeoff	315,000 lb.
Maximum landing	257,500 lb.
Equipped weight empty (civil domestic)	124,800 lb.
Equipped weight empty (military)	128,400 lb.
Maximum payload	93,000 lb.

Fuel System

Capacity	23,080 U. S. gal.
Single point refueling rate	900 U. S. gpm.
Jettison rate	700 U. S. gpm.
Fuel types	JP-4, JP-5 or kerosene

Powerplants

Four Pratt & Whitney TF33-P-7 (JT3D-8A) turbofans rated at 21,000 lb. thrust and with a predicted specific fuel consumption of 0.605

engineering and early production work on the aircraft.

Within Lockheed, lines of responsibility have been re-routed to give the C-141 project almost a separate identity. Yet this has been accomplished without interfering with more mature projects such as the C-130 Hercules and C-140 JetStars now being assembled. In general, the chain of C-141 command runs directly from Vice President Wagner to the assistant chiefs of the technical and administrative branches and divisions in the Lockheed plant here.

Thus the "assistant manager, manufacturing" is also "manufacturing manager, C-141," and as such commands support from procurement, assembly, fabrication, materiel and manufacturing subsections. While responsible to Lockheed's manufacturing manager, this assistant manager has direct access to Wagner on matters pertaining to the C-141. So do his counterparts.

Correspondingly, an authority equal to Wagner's has been invested in the C-141 program director in AFSC's Systems Program Office. Even relatively major decisions, therefore, no longer need be funneled up and down the parallel Air Force-Lockheed chains of command.

Through SOR-182, Air Force sought a rugged, reliable freighter that could be delivered in a hurry. As Robert I. Mitchell, director of marketing for Lockheed-Georgia, puts it: "The military didn't want a hot-rod," and as a result, "the C-141 incorporates no exotic design features because we didn't want to prove anything on this aircraft."

Wind Tunnel Tests

If any feature of the aircraft does represent an engineering breakthrough, that feature is the C-141's carefully faired afterbody with its unusual "petal door" arrangement. Before deciding upon the C-141's aft-end configuration, Lockheed explains, it staged a two-year wind tunnel test program, evaluating various empennage-fuselage combinations.

Results showed that at cruising lift coefficients, afterbody drag generated by the C-141's upswept fuselage and high "T" tail was as low or lower than that generated by the symmetrical em-

measurement and control

of pressure and differential pressure

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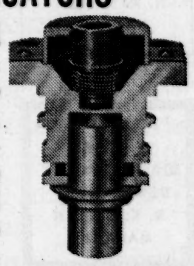

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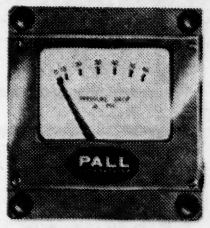

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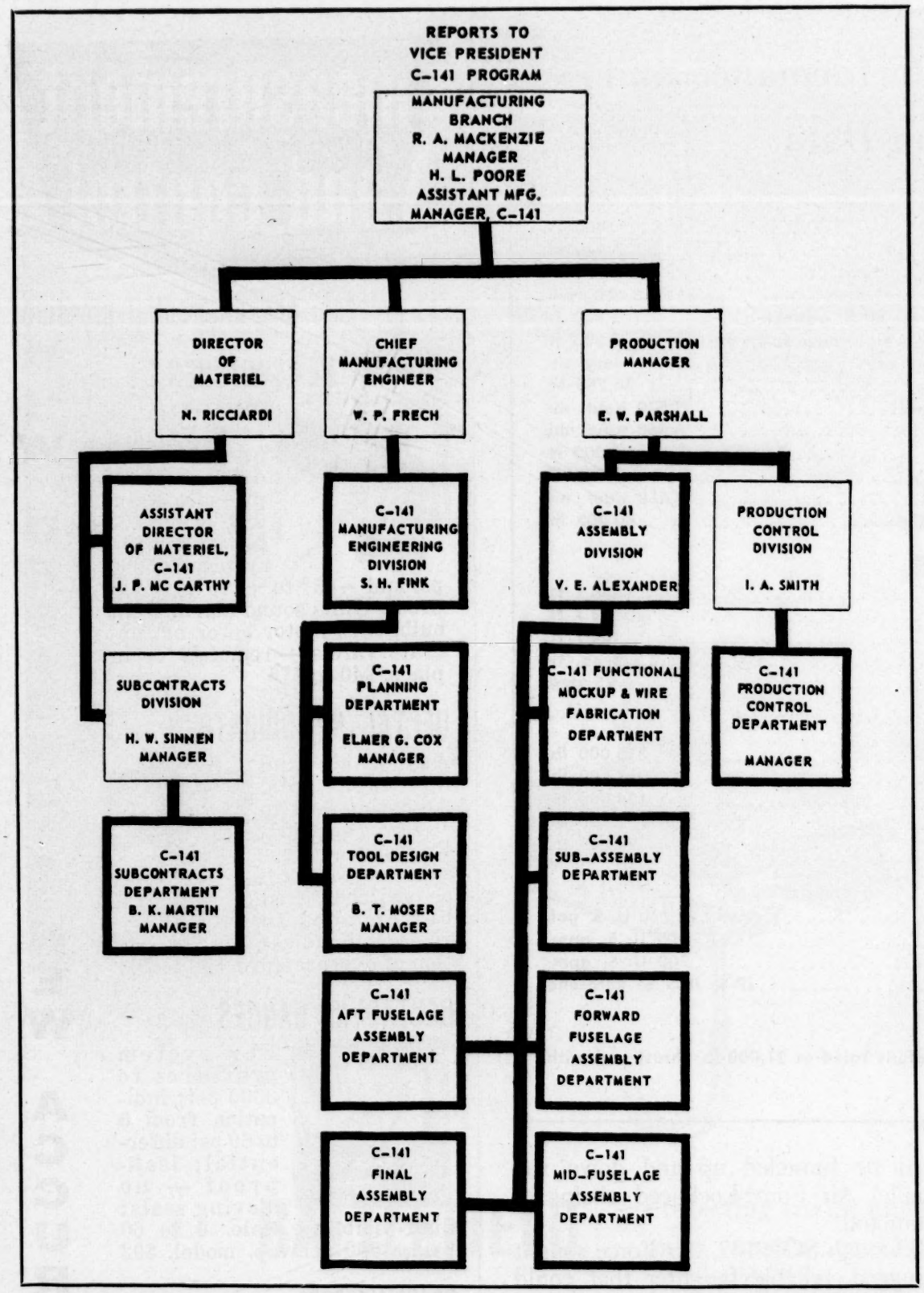

RESPONSIBILITY for carrying C-141 program through engineering and manufacturing stages generally has been entrusted to the assistant chiefs of Lockheed divisions. These officials have direct access to Lockheed Georgia Division Vice President C. S. Wagner, the over-all C-141 project manager. Organization reflects the top-level priority accorded the C-141 program by Lockheed.

pennages of many current airline transports. When the C-141 design was tested at speeds substantially higher than cruise, however, its afterbody drag exceeded that generated by more conventional tail configurations. Lockheed feels that this fact is irrelevant because the C-141 was not meant to cruise at exceptionally high subsonic Mach numbers.

For airdrops at speeds under 200 kt., the C-141's two petal doors swing outward, paralleling the airflow along the freighter's fuselage. Each door is hinged longitudinally into two sections. As the tapered upper sections begin their travel, the lower section on each side reacts inward and upward. This action completely exposes a combination pressure bulkhead-cargo loading ramp that seals off the freighter's hold about 35 ft. forward of its tail tip. This bulkhead, when closed, eliminates pressurization loads on the petal doors, minimizing structural and sealing problems.

Ramp Is Angled

Hinges cross the bulkhead laterally at its midpoint. The lower section thus created is the ramp. In flight, it angles aft and up 11 deg. to the plane of the cargo floor and is stressed to support an additional pallet of cargo.

During airdrops, or during truck-bed height loading operations on the ground, the whole bulkhead is hydraulically lowered to form a flat extension of the cargo floor. Across this surface, parachutes can pull a 35,000 lb. armored reconnaissance assault vehicle without damage to the platform.

Similar or smaller vehicles may drive directly into the C-141's 7,156-cu.-ft. cargo envelope if the bulkhead is fully extended so that its upper or aft edge touches the ground.

C-141's cargo compartment is slightly over 9 ft. high, 10 ft. wide and 70 ft. long with its floor 50 in. above and parallel to the ground.

With an aspect ratio of 7.9 and an average-thickness-to-chord ratio of 11.2%, the C-141's wing sweeps back at a moderate 25-deg. angle. Wing sweep on the Boeing 707, by contrast, is 35 deg., while the Douglas DC-8 uses 30 deg. According to Lockheed, the C-141's slightly swept wing has a host of built-in advantages, among them: less yaw or sideslip-induced roll, better aileron control at low airspeeds, no need for inboard ailerons or spoilers (except to kill lift after touchdown), no tip stall problems, improved stability during speed changes and high maximum lift coefficients.

Average cruising speed for minimum direct operating cost (DOC) is fixed at about 440 kt. by the C-141's powerplant and 25 deg. of wing sweep. According to early Lockheed parametric studies, high-speed cruise would be about 466 kt. This latter figure could be boosted only by about 7 kt. had wing with a 35 deg. sweep been selected, assuming that Air Force requirements remained unchanged.

Cautious Word

"Just because you've got a contract doesn't mean you have a project sold," Wagner says of the C-141. Lockheed briefings already under way at U. S. Air Force bases reflect this company attitude. Even though final C-141 model specifications have not been ironed out with AFSC—they should be by the middle of this month—sales engineers from Marietta are stressing these points about the aircraft:

• **Growth potential.** Lockheed looks upon the C-141 as at least a 10-year project; the "beginning of a family of freighters." It points out that its C-130 series aircraft have "grown" 43%, from a gross weight of 108,000 lb. in 1956 to 155,000 lb. in 1961. Comparable stretch has been designed into the C-141 and users can exploit this potential as soon as turbofans with greater thrust are developed.

• **Ease of maintenance** achieved through the use of proven components and structures. For example, the C-141 wing is of conventional box-beam construction. Fuselage is of longeron, ring and skin construction, and has a cross-section identical to the C-130. An internal ladder enables workmen to climb through the multi-spar skin and rib

He has a hand in planning for the men in the moon

He's one of a staff of AMF engineers who are solving space environment problems on a here-and-now basis.

He has plans for an orbital launch facility (picture, top left) to help them get there in the first place. Inside, in a shirt-sleeve environment (top, right), a space vehicle can be prepared for launch to the moon itself. On the moon (center), connected structures above and below the surface are required for the Advanced Habitation Engineering needed to support a permanent lunar base. Lunar traverser (bottom) is used to move men and materials and assist in construction of a permanent base.

Already, AMF has designs and concepts which make those pictured obsolete. As new knowledge becomes available, AMF quickly incorporates it into simpler, more reliable, more easily fabricated mechanisms.

AMF has completed and is now carrying on studies and feasibility investigations covering a wide range of space environment problems in conjunction with space vehicle manufacturers and for several government departments. Space environment, itself, is just one of a virtually complete spectrum of AMF defense capabilities.

For more information, write American Machine & Foundry Company, Government Products Group, AMF Building, 261 Madison Avenue, New York 16, N. Y.

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Lockheed C-141 History and Timetable

Specific operational requirement 182	May 4, 1960
Development plan	Aug. 10, 1960
First development directive	Nov. 23, 1960
Procurement authorization	Mar. 16, 1961
Air Force letter contract (five aircraft)	Apr. 7, 1961
First Subcontract	Aug. 16, 1961
Rollout	Aug., 1963
First flight	Nov.-Dec., 1963
FAA certification	Jan., 1965
First operational unit	June, 1965

structure of the C-141's fin to inspect or repair control surfaces at off-line stations without elaborate support equipment. Located under the freighter's center of gravity, the main gear (and the nose gear) will fall free and lock, unassisted by hydraulic pressure.

• **Short field capability** without sophisticated high-lift devices. Preliminary analyses indicate that the C-141 could leave Denver for New York with a full payload and reserve fuel on a 103 deg. day, even though Denver is 5,280 ft. above sea level. Under military conditions, the aircraft can land on a 3,500 ft. strip at its maximum landing weight.

Flexibility of the C-141, in that it can land or drop troops or heavy equipment into a combat zone, coupled with its range and speed, undoubtedly will slice the time it takes the U.S. to react militarily to global crises. During last spring's Operation Solidarity in Panama, for example, Tactical Air Command C-130s flew Strategic Army Corps paratroops nonstop from bases in the southeastern U.S. to Central American drop zones.

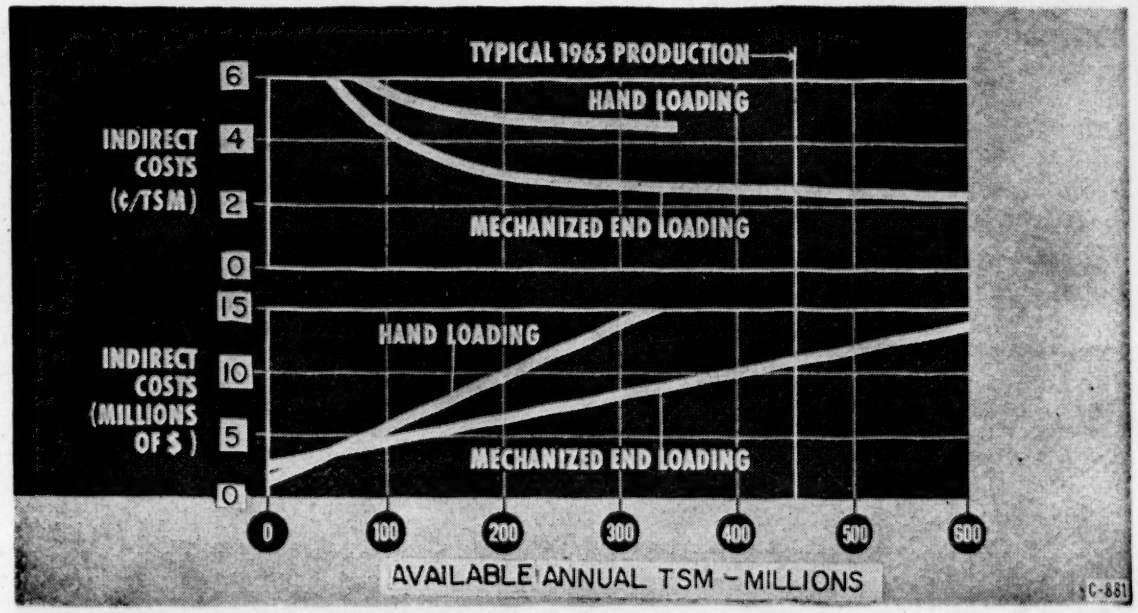
After roughly a 6-hr. flight, STRAC troops donned their chutes in the air, then executed a successful "combat" jump. This technique, if necessary, could be employed with the C-141, but over far greater distances. Paratroops would suffer less flight fatigue with the lower noise and vibration levels inside the transport.

Concurrently, a MATS spokesman told AVIATION WEEK, the service plans to complete its phase-out of aging, "short-legged" Douglas C-124s and C-118s initially and the remaining Lockheed C-121s when the C-141 becomes available. As a result, MATS' reliance on island or foreign refueling bases will be lessened.

Such strong points would seem to guarantee the new transport a successful military future. But whether U.S. airlines will acquire the L-300, commercial counterpart of the C-141, still is an open question.

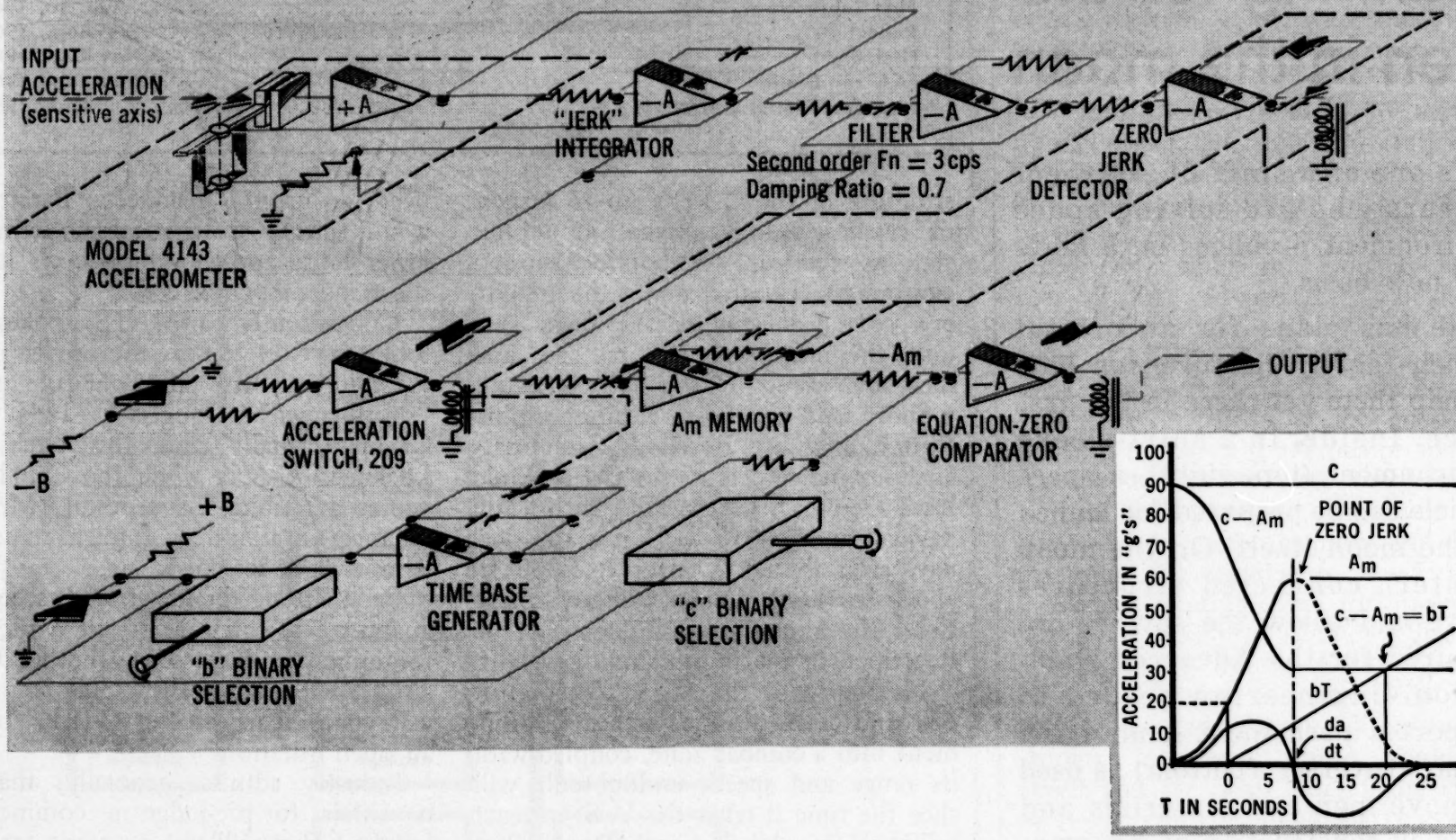
Industry admits, generally, that it is unfair to pre-judge a commercial freighter that will not be ready for five more years. Nevertheless, initial airline reaction has not been favorable and criticism has centered on these contentions:

Department of Defense and Federal Aviation Agency failed from the outset to give airline requirements sufficient weight in drafting SOR-182; the L-300 lacks the flexibility to meet the requirements of carriers with contrasting route structures; the L-300's ability to oper-



TOP CURVE plots the relationship between L-300 indirect costs in cents per ton statute mile (TSM) and aircraft's ability to produce TSMs of cargo. Bottom curve plots these costs in millions of dollars. Note the effect of mechanized end loading on both. Presentation is based upon Lockheed analysis of two typical domestic and two typical international routes likely to be flown by the L-300.

Functional Diagram of Donner Accelerometer Timer Switch. Basically an airborne computer designed to solve a specific equation, this Donner device consists of a force balance accelerometer, whose output feeds to a jerkmeter for determination of peak acceleration (Jerk (da/dt) is the first derivative of acceleration). From the jerkmeter the signal passes through a filter and to a zero jerk detector which closes a switch at the peak acceleration. Other units in the computer are a peak acceleration memory, a 20 g acceleration switch which starts a time base generator and prevents the zero jerk detector from operating before a correct solution is possible, "b" and "c" selection binary units allow 64 values of "b" and "c" to be selected within the operating range, and an equation zero comparator which algebraically sums the output of the maximum acceleration memory circuit, time base multiplied by "b" and "c" circuit to close the relay output when $bT = c - A_m$. The curve below illustrates the equation and the fact that peak acceleration occurs at zero jerk.



How to Solve a Flight Equation

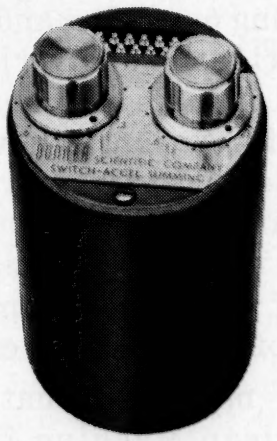
New Donner Airborne Analog Computer solves equation $bT=c-A_m$

where b = predetermined constant, T = time in seconds,
c = predetermined constant, and A_m = peak acceleration achieved.

Causing a missile event to occur at just the right time and place in space is one of the critical problems faced by the control engineer. The programming device must be light, accurate, strong and, above all, reliable in severe environments.

When Donner engineers were confronted with this problem, they came up with a fixed purpose airborne analog computer known more specifically as an acceleration summing switch. The summing switch is a "thinking" device which responds to a particular environmental stimulus. Thinking for the vehicle, the switch measures time, multiplies it by a preset constant, equates the product to the memorized peak acceleration subtracted from a constant and when the sum reaches a predetermined value, actuates a relay. Such a point occurs during decreasing acceleration and is dependent on the magnitude of peak acceleration.

In solving this problem, Donner engineers combined their experience with computer techniques and servo force balance accelerometers. The device illustrated is all solid state.



Acceleration Summing Switch. This remarkable small computer is approximately 4" high and 2½" across. The two knobs on the top are used to set in "b" and "c" constants of the equation.

COMPLETE TECHNICAL INFORMATION AVAILABLE
If you would like more information about this interesting application of computer and transducer techniques, our Mr. Stephen P. Cuff has prepared a technical discussion which he will be happy to send along. Please write Mr. Cuff at Donner Scientific.

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ate from 6,000-ft. strips implies a weight or design trade-off that may boost DOCs; the L-300's fuselage cross-section is too large to be profitable in the current cargo markets; and Lockheed has failed to produce precise cost and capability statistics on the aircraft.

For these reasons, it cannot be said that the C-141 is a government subsidized transport designed and ordered to fulfill both civil and military needs, the airlines have argued. As one highly-placed industry representative explains it: "A number of airlines have examined both the specifications and the information now available on the C-141 and their reactions vary from positive conviction to serious doubt that the plane will have . . . commercial utility."

The case opposed to this line of thinking emphasizes that it is a point of national policy to produce "aircraft responsive to both civil and military needs." As a result, FAA sought civil carrier cargo aircraft specifications through a request dated Dec. 4, 1959. Response came from 25 airlines offering 29 sets of specifications. From these, FAA furnished the drafters of SOR-182 with a cross-section of civil all-cargo requirements.

Comparative tables show that when the minimum and maximum performance requests submitted by the airlines are averaged, the figures that result closely approximate L-300 capability.

As to the L-300 itself, Lockheed has informed the airlines that the freighter will have an empty equipped weight from 2,800 (international version) to 3,600 lb., less than that of the C-141. This weight saving—gained by eliminating military loading equipment, installing a lighter floor, removing the hydraulic system that enables air delivery, etc.—usually equals extra payload.

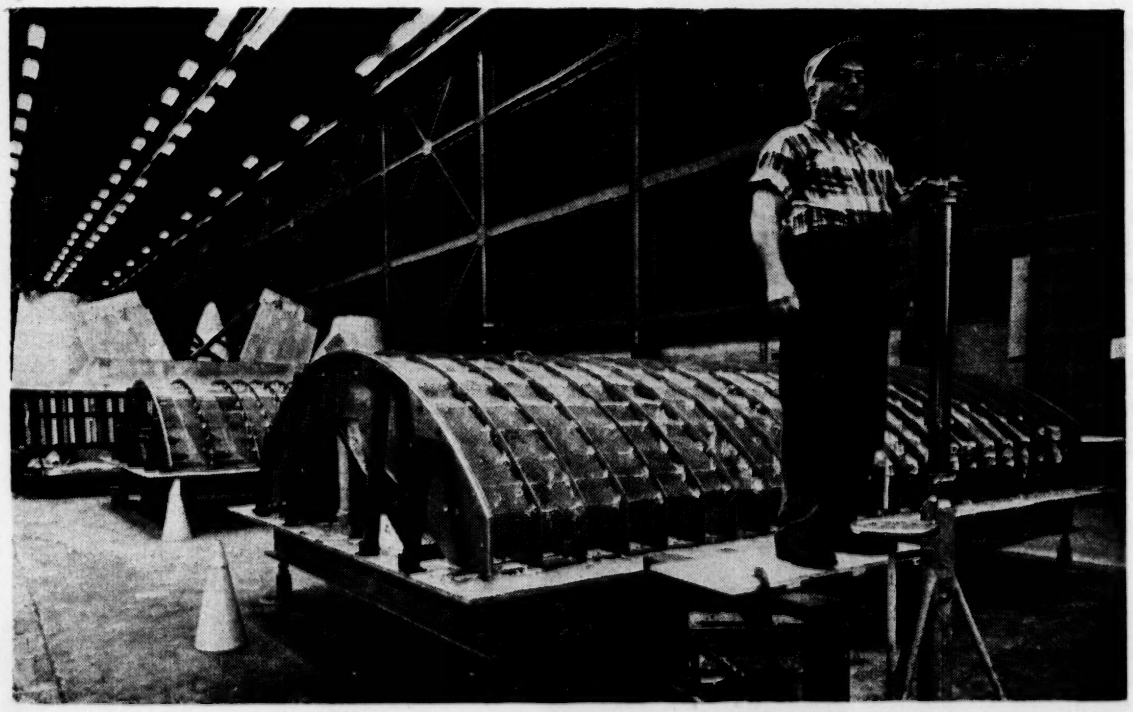
Maximum payloads for the domestic version of the L-300 range from a low of 82,000 lb. at 3,450 naut. mi. to 93,000 lb. at 500 naut. mi. For transcontinental westbound flights against average headwinds, takeoff weight is about 292,800 lb., payload 85,000 lb.

International version of the L-300, cruising at about 25,000 ft., can make a transatlantic crossing from New York to London with 83,000 lb. of payload. Payload from New York to Frankfurt with average winds is 82,000 lb. En route airspeed for both operations would average 505 mph.

Based on Air Transport Assn.'s formula for computing DOC, an L-300 selling price of $5.5 million and a utilization rate of 3,650 hr. per year, the domestic aircraft's direct operating cost is as low as 3.8 cents per ton statute mile (TSM) over ideal stage lengths of 2,200 naut. mi. Over 1,000 and 3,250 naut. mi. stage lengths, DOC rises only to 3.9 cents per TSM. At 500 naut. mi., comparable figure is 4.4 cents. The L-300's relatively constant DOC, in Lockheed's view, rebuts the airline argument that the freighter may not be adaptable to widely differing route structures.

Breakeven cargo load factor for the domestic L-300 is 63% on a 2,200-naut.-mi. operation, airlines have been told. This assumes minimum DOC of 3.8 cents, indirect costs of 2.5 cents per TSM and a reduced revenue rate of 10 cents per ton statute mile. International version of the L-300, over 3,000 naut. mi. schedules, has a 50% breakeven point at revenue rates of about 13.5 cents per TSM and DOCs of 4.4 cents per TSM.

The C-141/L-300 is scheduled to receive a Type 4B FAA certification, which would qualify the aircraft to carry both passengers and cargo, in



LOCKHEED tool-maker stands before master models of C-141's aft fuselage section. Metal pieces and wire screening will be filled with smoothly contoured plastic, then serve as a model for various fabrication and assembly tools.

Engineered Environment

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Engine Tests Under Way

Pratt & Whitney reports that its TF33-P-7 (JT3D-8A) turbofan engine powerplant selected for the Lockheed C-141, now is undergoing full-scale tests including thrust output and endurance runs.

Preliminary power measurements indicate the engine will meet guarantees on both thrust (21,000 lb.) and specific fuel consumption, according to P&W. Engine is scheduled for military qualification tests in January, 1963.

January, 1965. To ensure that this target date is met, FAA engineering test pilots—along with their counterparts from Lockheed and SPO—will occupy seats in the cockpit as the C-141 undergoes flight tests. Such three-way supervision will characterize the C-141 program as it unfolds.

Nevertheless, it is probable that even if commercial carriers order early, service with the L-300 cannot be inaugurated until sometime in 1966. By then, Lockheed reasons, the volume of cargo moving on international and domestic air routes will have climbed to the point that makes a 70,000-lb. payload freighter a profitable instrument.

Lockheed also feels that while airlines are awaiting the new transport, interim freighters such as the Canadair CL-44, Douglas DC-7F and Lockheed 1049H will develop markets that the L-300 can more fully exploit. At the same time, improved techniques of packaging and handling airfreight will boost the profit producing potential of the L-300's quick turnaround capability.

Fiscal burdens of the missile age, Lockheed believes, virtually rule out both a Strategic Air Command on-runway alert and a comparably ready Military Air Transport Service large enough to satisfy airlift needs during national emergencies. But the U. S. can count upon a self-supporting transport fleet rapidly available to the military during crises if commercial carriers acquire L-300s, the company maintains.

Answering airline complaints on the absence of precise L-300 cost and performance data, Vice President Wagner stresses that final C-141 model specifications still are being negotiated with Air Force. When these have been thrashed out, Lockheed intends to furnish interested airlines with every pertinent L-300 detail for their review.

When the C-141 project got under way, Lockheed's lines of commercial communication ran through SPO to FAA to the Air Transport Assn. to the individual airlines. But this circuit has been shortened by Lockheed, which now intends to deal directly with prospective airline purchasers of the L-300.

CAPABILITIES REPORT FROM BENDIX PIONEER-CENTRAL

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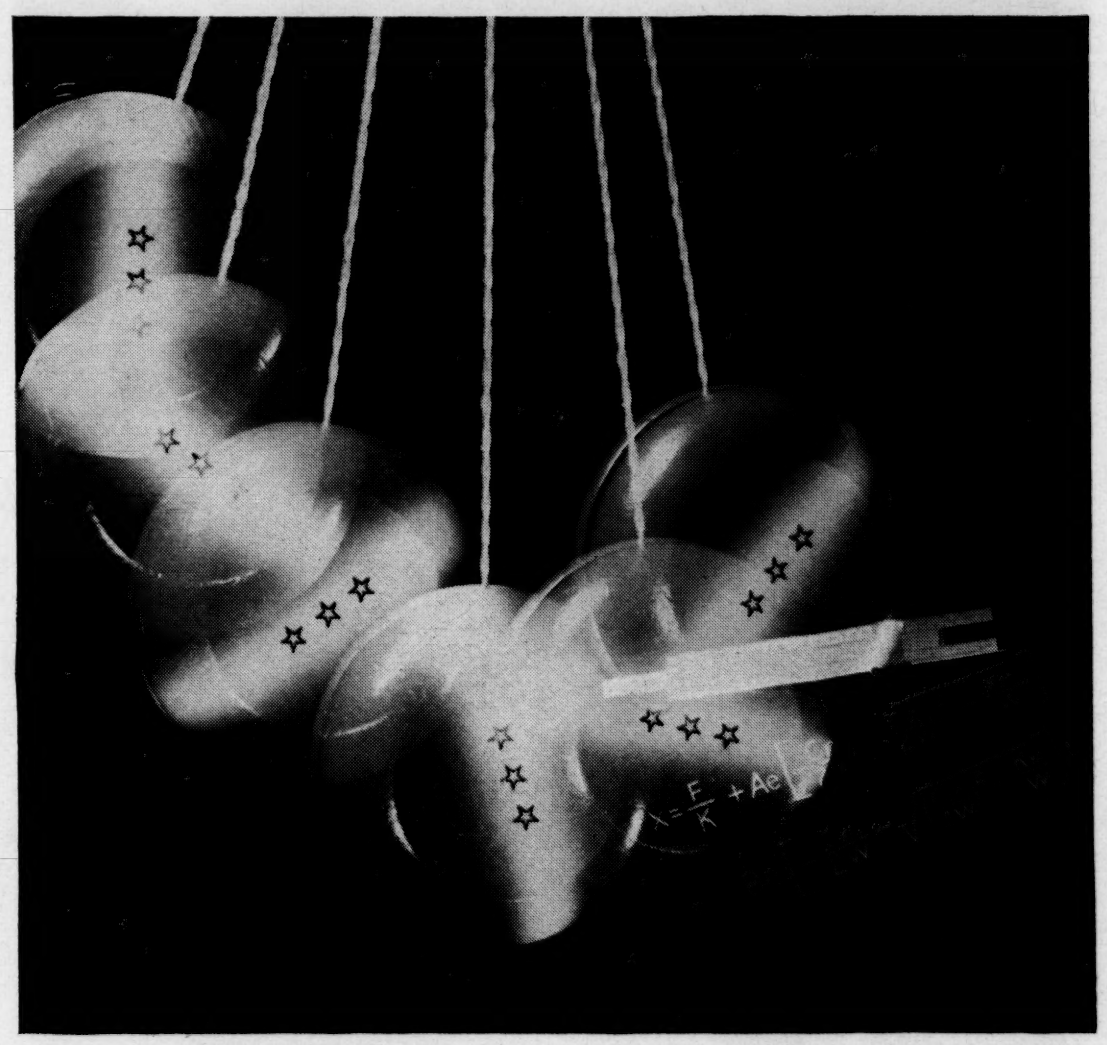

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Rolls Studies Lift-Jet Engine Applications

By Herbert J. Coleman

London—Rolls-Royce engineers are studying possible layouts of lift-jet engines in tactical and transport aircraft and claim that two types of VTOL airplanes can be developed in the near future, using data now available or the results of current research and testing.

The airplanes, according to G. L. Wilde, chief of preliminary design, are a short-to-medium range strike aircraft, capable of high subsonic speeds on the deck, and a transport which could have either VTOL or STOL characteristics.

One strike fighter, a new configuration, would have a low aspect ratio wing and the four lift engines would be installed in two pairs at the front and rear of a central weapons bay. Propulsion would be by two pure jets in the wing roots.

This airplane, Wilde said, has a layout that presents no great difficulties. Pitching moment from an engine failure would be greater than that experienced by a cranked delta planform and thus would need a greater lift-thrust/weight ratio.

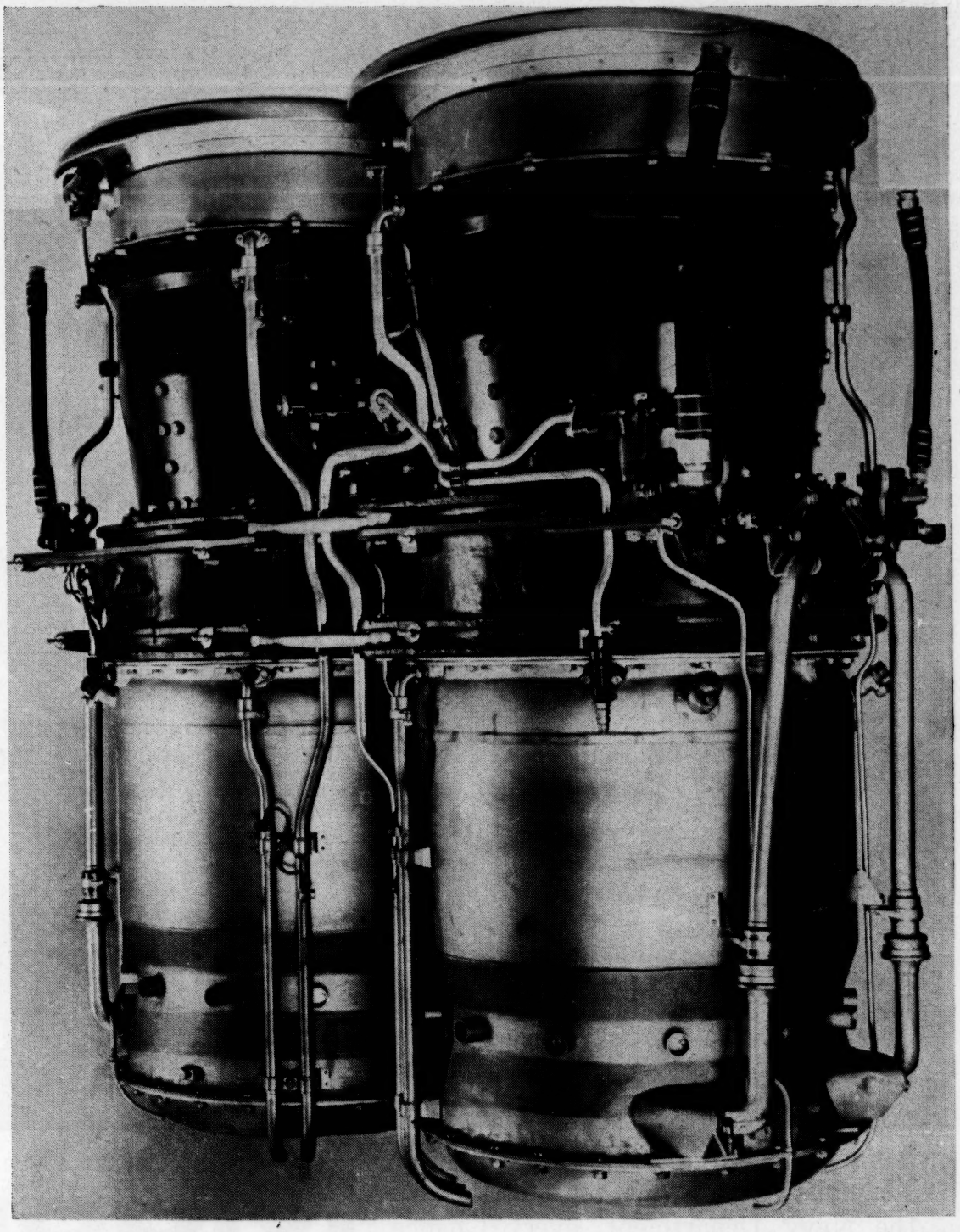
A cranked delta type explored by Rolls follows the aerodynamic layout of the Saab Draken and the engine layout of the Short SC.1 VTOL, which is powered by the Rolls RB.108 lift-jet powerplant. In this model, the airplane has four lift engines in the center fuselage and a single bypass engine for propulsion.

Both airplanes, Wilde continued, are stabilized during the hover and transition stage by control jets in the wingtips and fuselage, fed by compressed air bled off the lift engines. Thrust of the control jets would be regulated by an auto-stabilizer unit.

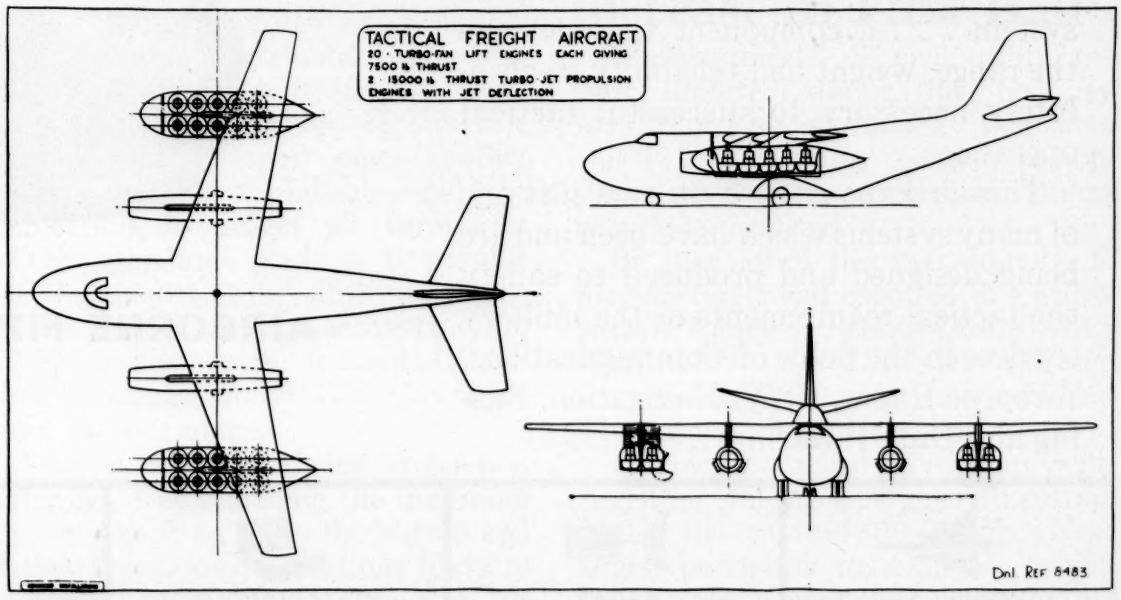
Rolls' basic policy is manufacture of aeronautical engines, not aircraft design, but Wilde said the studies were made to guide future planning of aircraft engines. Studies envision uses of both turbojet and turbofan types.

Wilde pointed out that it now is possible to design a lift-jet engine with a thrust up to 16 times its weight; this compares with the thrust/weight ratio of 8:1 for the RB.108, which has gained more than 4,500 hr. of testbed and flight experience.

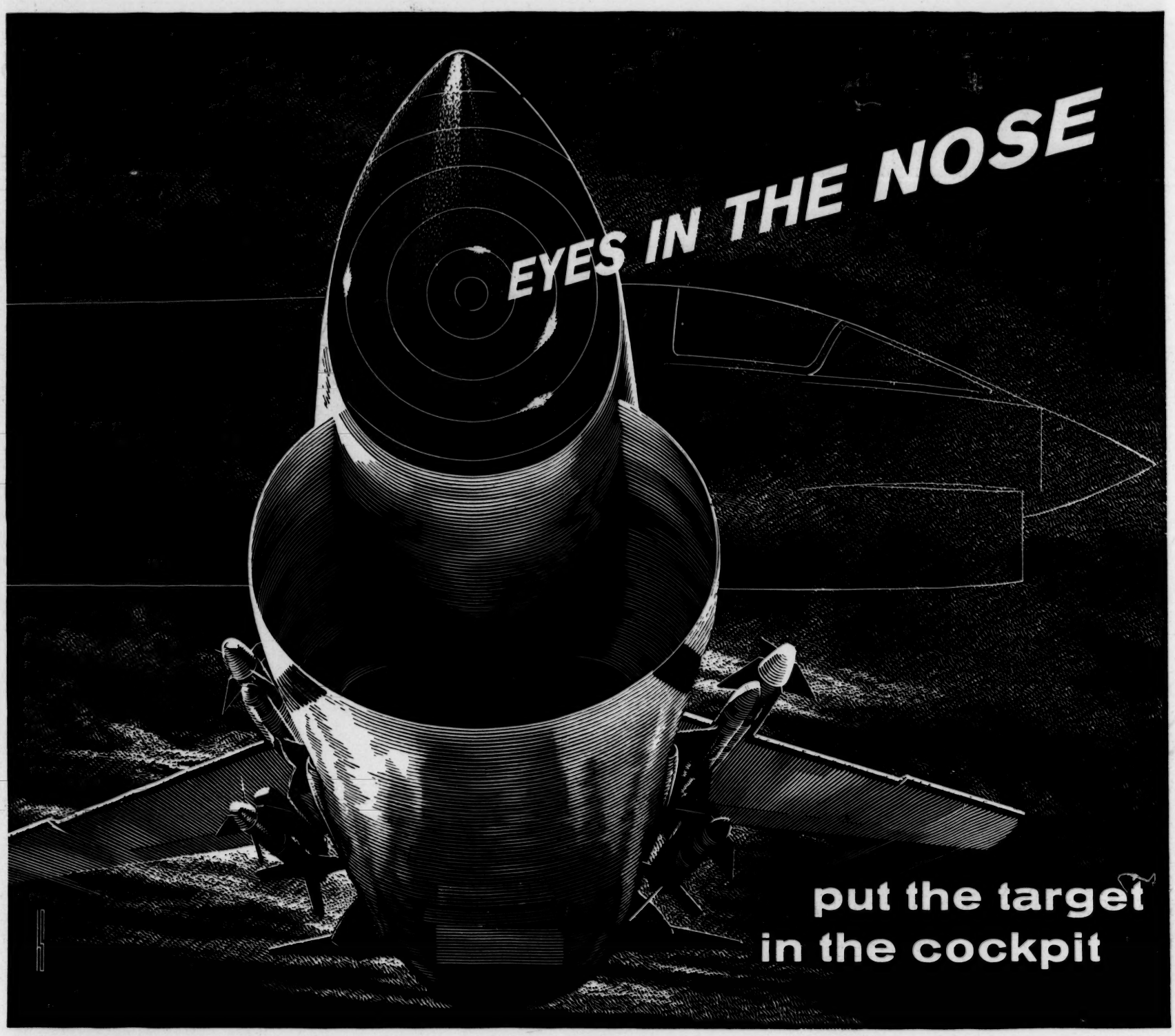
Rolls presently is running the RB.108 in extensive cycling tests to determine the basis for service life. The engine, which produces 2,200 lb. thrust with a 10% compressor bleed, and 2,500 lb. thrust without bleed, could be developed to a 3,000 lb. thrust engine with a 10:1 thrust/weight ratio. However, Rolls believes it now is possible to design a lighter, cheaper and more simple



ROLLS-ROYCE RB.108 lift-jet engines are displayed above in paired configuration. RB.108s have accumulated more than 4,500 hr. of testbed and flight experience, according to Rolls-Royce. The engine has a thrust-to-weight ratio of 8:1. The RB.108 lift-jet engines are shown as they would be installed in vehicle (AW Sept. 18, p. 81).



TACTICAL TRANSPORT, as envisioned by engineers at Rolls-Royce, would have 20 turbofan lift engines in wing pods. The tactical transport would have two pure jet engines fitted with jet deflection for forward propulsion.



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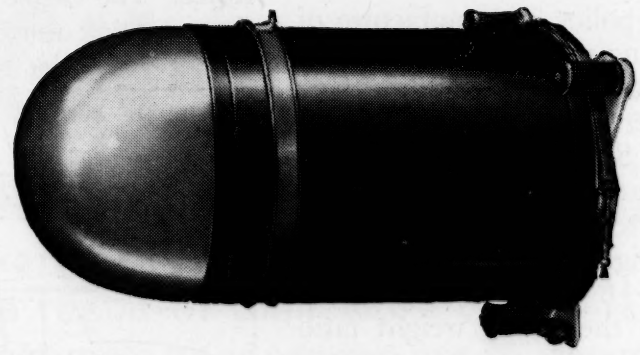

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engine with cost per unit of thrust cut to less than half that of a propulsion engine of the same thrust. Engine simplicity and advances in materials are the key to this saving.

In considering aircraft application involving lift-jets, Wilde thinks the best approach is to design the airplane for VTOL operations from the start, noting that for satisfactory maneuverability during vertical takeoff and landing, a thrust/weight ratio of 1.2 is necessary. For STOL performance, based on reaching 50 ft. altitude in a distance of 500 ft., it is necessary to deflect thrust during takeoff at a low forward speed and Wilde said airplane aerodynamic controls will not provide sufficient pitch and roll control for safe operations.

Design parameters for an STOL airplane, he said, would call for a choice between a single engine whose propulsive thrust could be deflected for lift, or a composite power source with separate propulsion and booster engines, all of which have a means of thrust deflection. Thrust/weight ratio of 1.05 is needed in both cases, according to Wilde.

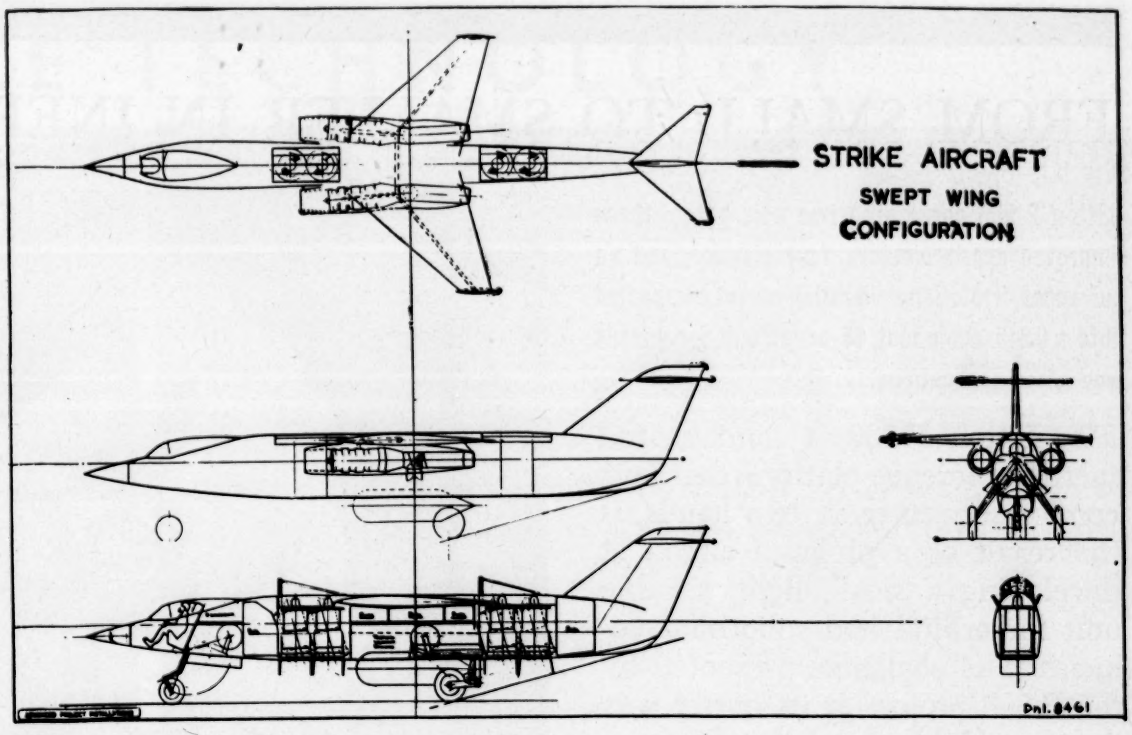
Referring to the single-engine design, Wilde said the engine must be a compromise between takeoff and cruise requirements; it will have too much thrust for subsonic cruise and would need a medium pressure ratio to keep specific weight low, along with high bypass ratio to cut fuel consumption. It also would have poor specific fuel consumption at high subsonic speeds because the engine would be well throttled back.

The composite powerplant of separate propulsion and lift engines, deflecting thrust for takeoff, can be designed without the need for compromise. In addition, the airplane with the composite engine will be much smaller than the single-engine aircraft, particularly if the composite has a bypass propulsion engine producing a good specific fuel consumption.

Cruising the single-engine plane at an economic speed of Mach 0.45, Wilde said, would call for throttling to 12% of maximum thrust; the composite type would call for throttling to about 20% of the maximum rating.

Two main multiple engine layouts are possible for the VTOL strike aircraft, the engineer explained. They are:

- **Layout in which** the propulsion engine thrust is diverted vertically to add to the vertical thrust of the lift engines.
- **Provision for all lift thrust** by light weight booster or lift engines, such as the Short SC.1, with no deflection of the main propulsion engine, thus eliminating need for heavy and bulky jet deflectors. This approach also avoids the design problem of placing propulsion engines so that the deflected thrust line passes through the airplane's center of gravity, or close to it.



SWEPT WING strike fighter has lift engines placed fore and aft of the weapons bay.

With both types, Wilde said, lift engine thrust can be tilted by up to ±30 deg. from vertical with small weight penalties and a large horizontal thrust component can be provided to assist in acceleration or deceleration.

To estimate weights of a VTOL airplane for low level strike missions, the Rolls team selected a delta planform with low aspect ratio, omitting high-lift devices and assuming a lightweight landing gear. With these restrictions, a structure weight of 18-20% of takeoff weight would be possible, against 28-30% for the STOL airplane.

Turning to the tactical transport field, Wilde mentioned two possibilities, both involving conventional airframes except that pure lift-jet engines or lift fans would be encased in pods on the wings. One model would use two Tyne engines for propulsion, with 32 clustered lift engines, and the other 20 fan lift engines plus two 15,000 lb. thrust propulsion engines equipped with thrust deflectors.

This type of approach would be useful in gaining operational experience, but the arrangement, Wilde said, offers little scope for reduction of structure weight. The transport poses another problem in that it probably would be impractical to deflect all thrust for STOL operations, such as is possible for the smaller strike airplane. Wilde claims that if the 500 ft. distance to 50 ft. height variety is needed, it is best to design for VTOL operation from the beginning.

Size or number of lift engines is determined by matching the maximum engine takeoff rating to the hottest and highest operational conditions likely to be met. At maximum rating, a lift engine would have an overhaul life of about 200 hr. However, the Short SC.1 takes 30 sec. from liftoff to forward flight and Wilde says it seems likely that lift engines in future military aircraft will run at full power for considerably less than 3 min., as envisioned in original lift-jet engine studies, but more possibly for 1 or 2 min.

Thus, a lift-engine could have an overhaul life of 800 hr., assuming 1 hr. sorties and that only 20% of the takeoffs were at maximum design rating at 100F and 2,000 ft., with the rest at sea level and landings at 80% of takeoff weight.

Lift engines also must have good starting characteristics, low idling speeds, fast acceleration times and rapid thrust response to sudden changes in fuel flow, Wilde said, mentioning that most of these requirements are met by the RB.108. This engine has a thrust response to throttle movement of about 0.1 sec., making it easy to control aircraft height by direct manual operation of the collective lift engine throttle.

Utility Aircraft Exports Increase in First Half

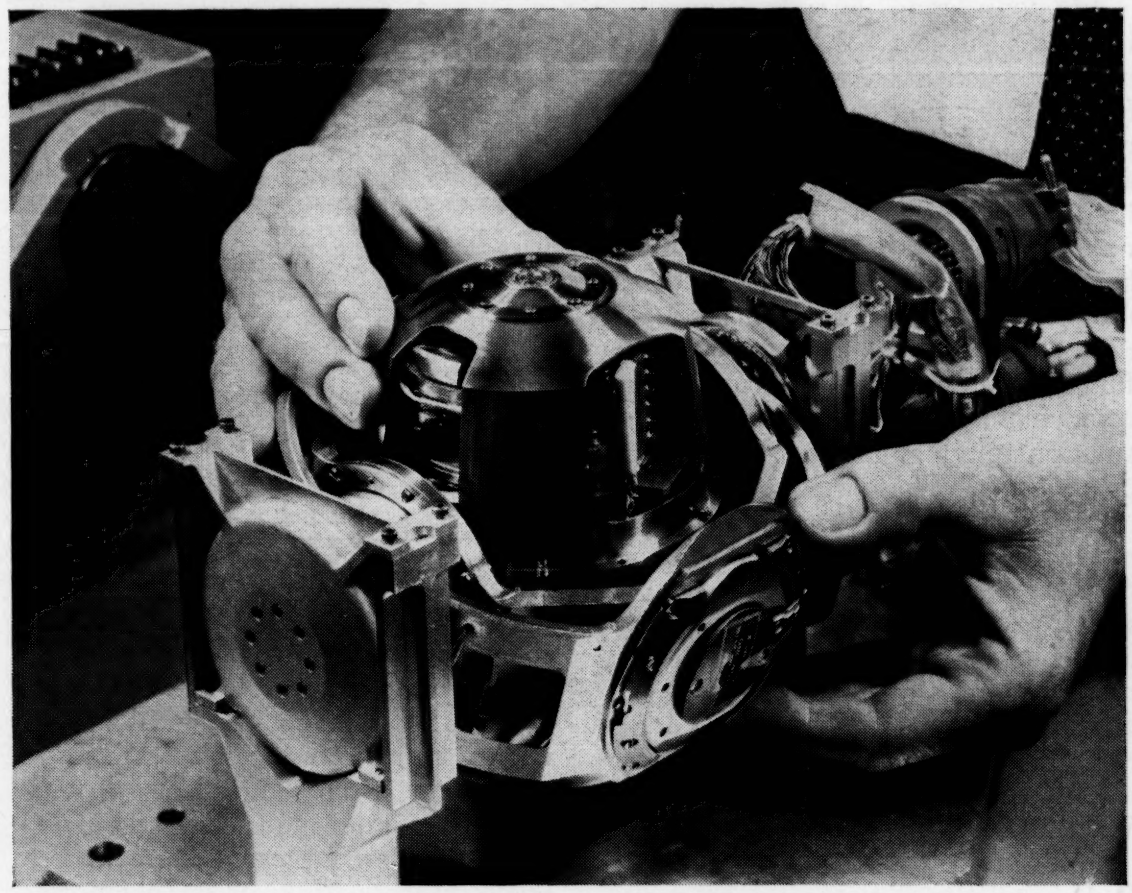
Washington—U. S. civil utility aircraft exported during the first six months of 1961 increased 23% in value and 13% in number over comparable shipments last year, Aerospace Industries Assn. reported.

By June 30 of this year, four U. S. manufacturers had exported 874 utility aircraft valued at $16,694,100. AIA's report only covered aircraft weighing less than 6,000 lb. empty and excluded all transport categories.

Shipments reached 65 nations, with Argentina buying 100 aircraft costing $1,989,100 to lead the group. Next largest purchasers were Canada, which bought 124 aircraft valued at $1,706,900, and West Germany, which bought 29 aircraft valued at $1,641,900.

FROM SMALL TO SMALLER IN INERTIAL PLATFORMS

Litton P-300 containing two new gyros, three improved accelerometers, four gimbals, and an advanced, irrotational vibration mount compacted into a 0.245-cubic foot, 15-pound unit for missile and space applications.



The Litton P-300, a miniaturized inertial reference platform that rests comfortably in one's two hands, is the result of a program aimed at developing a small, light, reliable unit for orbital and suborbital vehicles. The challenge presented by the P-300 project at its outset was the formidable one of taking an already small production platform (the 30-pound Litton P-200) and chopping it in half without sacrificing performance.

As in the P-200, floated, two-degree-of-freedom gyros were selected to minimize the number of gyro rotor assemblies and to simplify the stabilization servo loops. The gyros were made smaller and their performance increased through the reduction of minor error torques, such as those from flex leads making electrical interconnection between float and case. The gyro wheel, float, and gimbal were constructed primarily of beryllium, greatly improving the stiffness-to-density ratio and reducing the mass shifts caused by anisoelasticity under acceleration. Despite the smaller size of the gyro rotor, high angular momentum was obtained by distributing the rotor mass in a manner that provides a large radius of gyration.

Gas-lubricated bearings are another and particularly noteworthy improvement in the small (2.1″ by 2.9″), light (under 2 pounds) gyros. These bearings use 1/20th of the clearance between bearing surfaces normally associated with oil-lubricated assemblies and offer other advantages that improve gyro performance by an order of magnitude.

The accelerometers in the P-300 were scaled down (to 0.8″ x 0.8″ x 1.5″) through similar imaginative engineering techniques without decreasing performance. Small and greatly improved, these accelerometers contain a sensitive element that is a floated pendulum mounted on a pair of jewel-and-pivot bearings and equipped with an electromagnetic pickoff and torquer. The relative motion of the pendulum is kept to a small fraction of a milliradian even at an acceleration of over 20 g.

Another feature of the P-300 is the use of direct drive gimbal torquing. By incorporating this type of torquing, the weight penalty paid in motors and gear trains has been greatly reduced. In addition, direct torquing significantly increases accuracy of the attitude readout.

The P-300 inertial platform is the latest of more than half a dozen inertial navigation systems that have been successfully developed to the operational phase at Litton Systems. The Litton engineers who researched and developed these systems are always pleased to divulge additional details. Equally important, they are anxious to exchange ideas with new associates who have a sound flair for engineering of this sort. Write, phone or drop by for a visit. Mr. Don Krause, Litton Systems, Inc., Guidance & Control Systems Division, 5500 Canoga Avenue, Woodland Hills, California. Telephone DIamond 6-4040.

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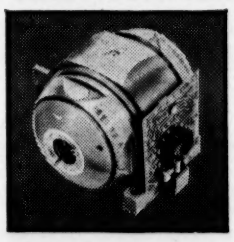

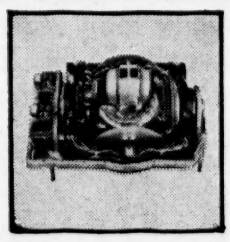

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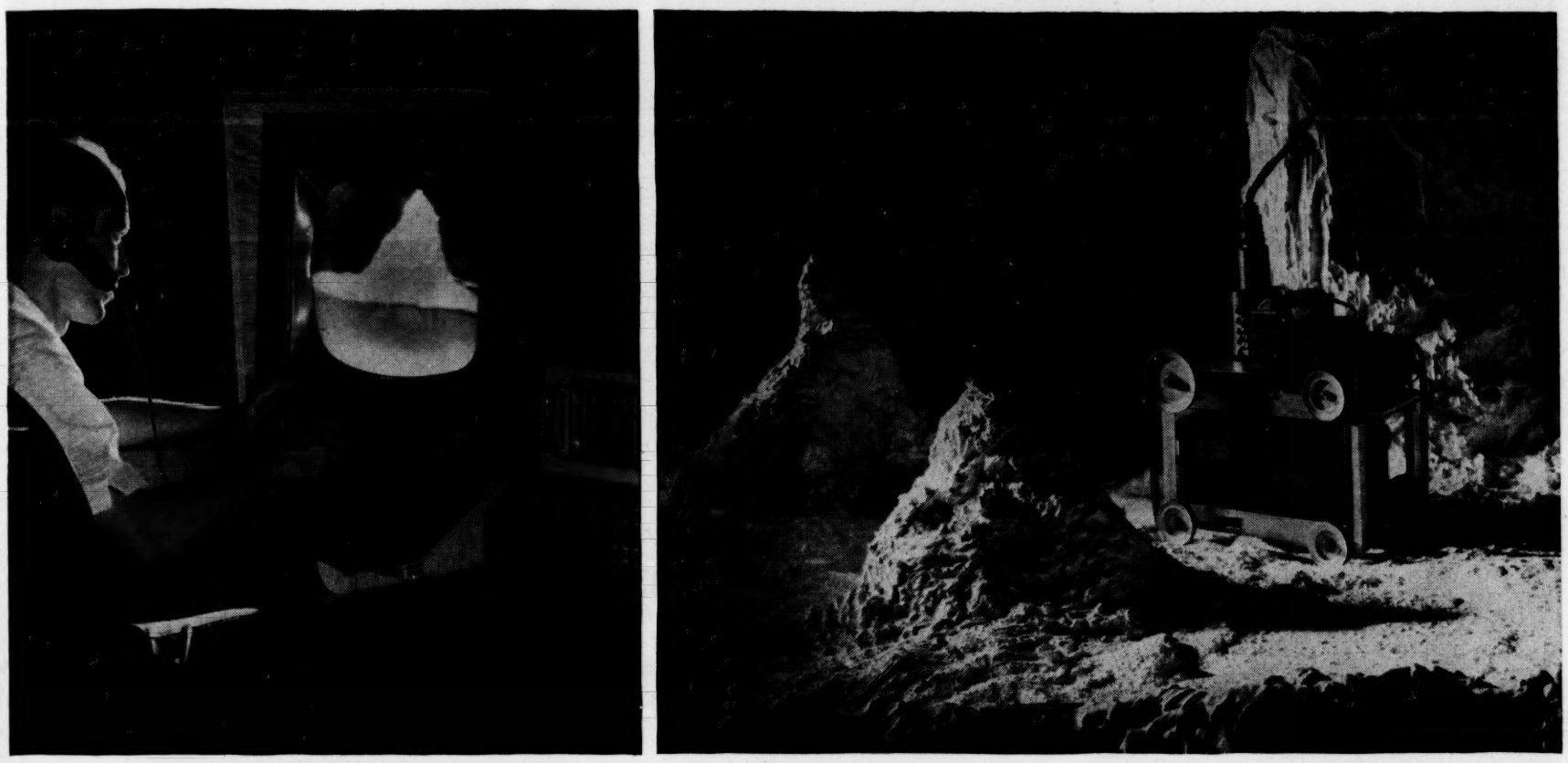


CONTROL OF A ROVING VEHICLE on the lunar surface by an earthbound operator is simulated in laboratory tests at Airborne Instruments Laboratory. Operator (left) maneuvers vehicle past obstacles in the path of a tracked model in a mockup of unfamiliar environment (right) by advancing or retarding control sticks for each vehicle track on the basis of a video presentation from a camera mounted on the vehicle. The company is trying to gain experience with problems of roving vehicle control.

Roving Lunar Vehicles—Part II:

Roving Vehicle Control Poses Problems

By Barry Miller

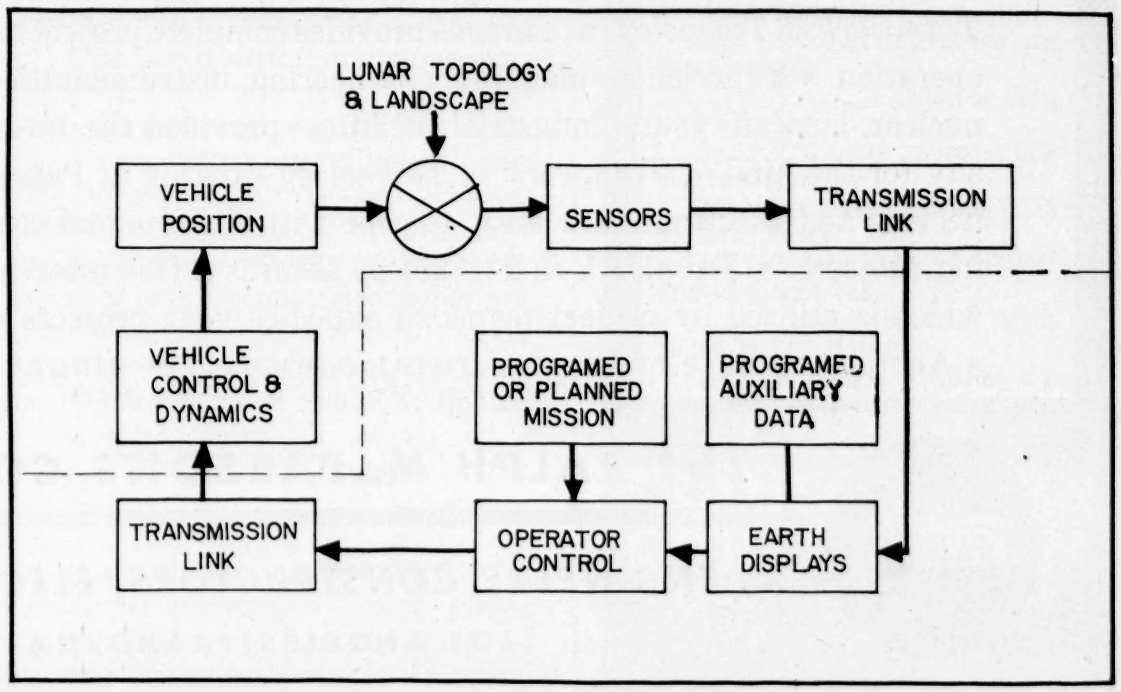
Los Angeles—Guidance and control of unmanned roving vehicles prowling about extraterrestrial surfaces hundreds of thousands or millions of miles from their human, earthbound operators pose a number of difficult problems which must be solved before the complicated missions planned for this new type of spacecraft can be achieved.

At the center of these problems is an extension of the same challenge, perhaps somewhat more extreme, confronting aircraft and automobile designers and operators alike. That is, how to enable the vehicle operator to anticipate the position and response of his vehicle. The amount of anticipation is a function of system parameters such as vehicle control response, vehicle speed and resolution of visual information, engineers at Airborne Instruments Laboratory point out. Airborne, a division of Cutler-Hammer, Inc., is one of several aerospace companies examining the problems of and seeking solutions for controlling mobile robot lunar vehicles from remote points on the earth.

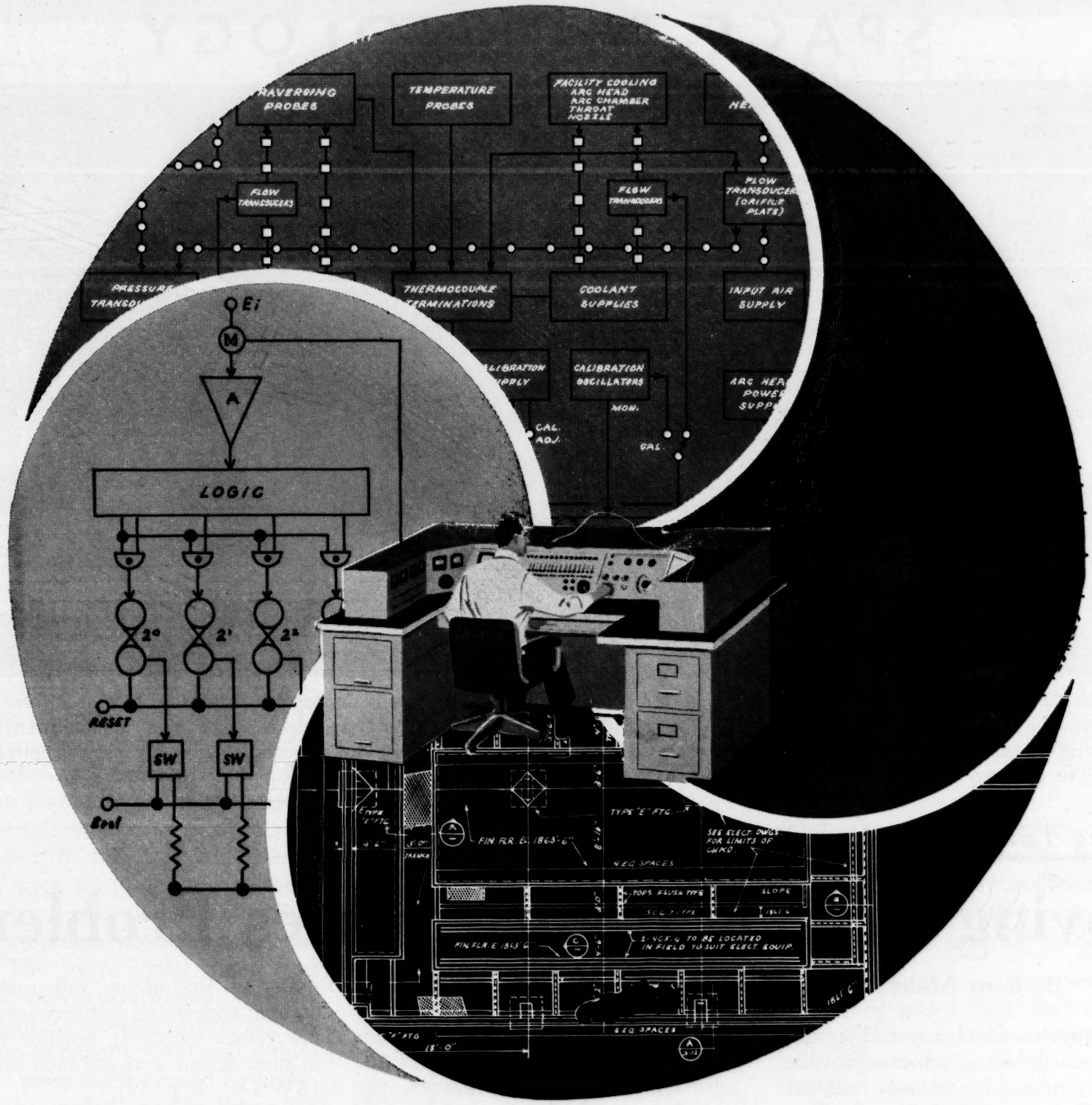
These companies are looking at prospective control techniques, suitable infrared, radar and television sensors that would constitute integral parts of vehicle control loops, realistic operator control displays and data transmission techniques.

Roving surface space vehicles, particularly lunar vehicles, that might prowl about the moon's surface securing scientific data, providing logistic support for manned lunar exploration and reconnoitering the moon and earth have aroused widespread industry interest. A few vehicle concepts, possible tradeoffs in their design were outlined previously (AW Oct. 2, p. 52).

Initially, a major purpose of extraterrestrial surface vehicles will be to perform missions in anticipation of man's arrival on the moon and other



ROVING LUNAR VEHICLE control loop includes earthbound portions—controllers, programs and communications (shown below the broken line) and vehicle dynamics, control and position, sensors, transmission link and inputs provided by terrain.



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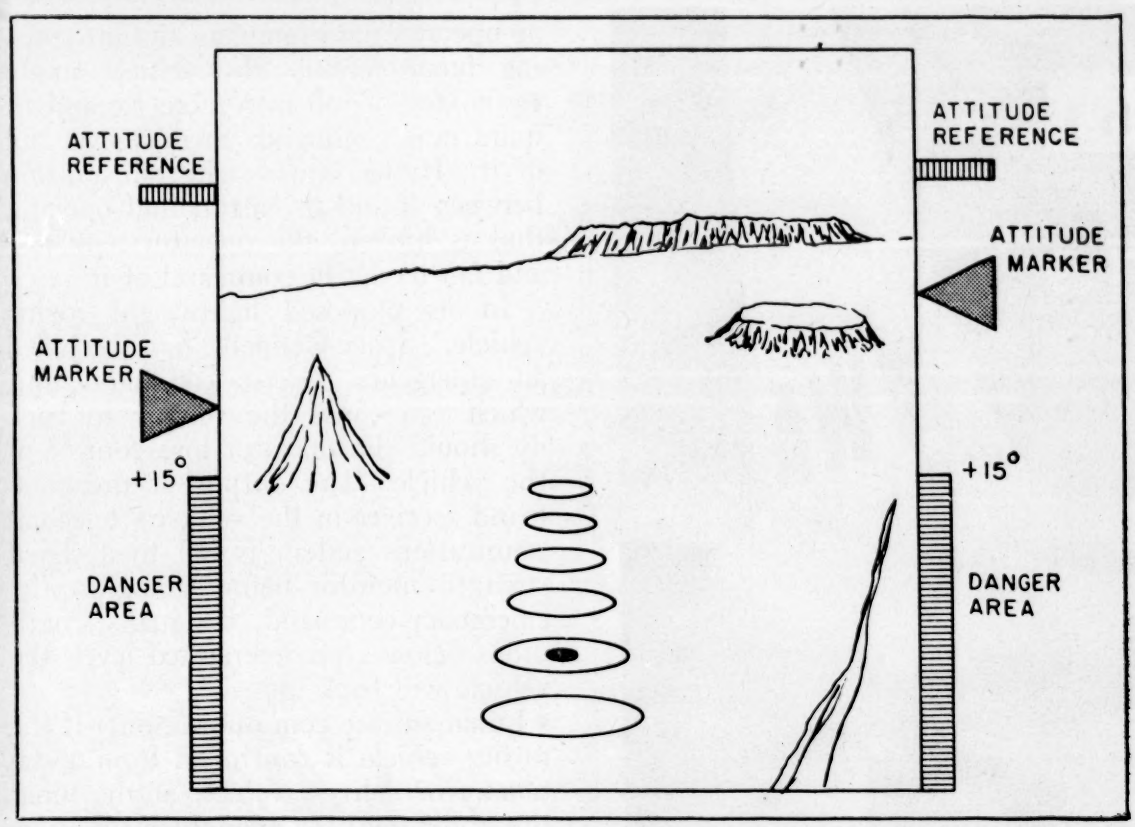

ATTITUDE DISPLAY for roving lunar vehicle might be desirable to keep the operator informed about unusual attitudes, such as when the vehicle is on a long, steep grade which might look level in normal video display.

planets or in lieu of it. The first generation of roving vehicles is expected to comprise unmanned craft remotely operated directly from earth control centers or by microwave radio link through a parent spacecraft which would ferry the roving vehicle to the moon and, sometime thereafter perhaps, to other planets.

A few of the difficulties and factors which complicate the control of roving surface spacecraft as cited by Airborne Instruments and others include:

• **Transmission delay**—The time required for electromagnetic signals to travel to and from roving surface spacecraft on the moon would be sizable and bothersome. This means that the controlled actions of a roving spacecraft are slower than they would be if the vehicle were on earth. If the vehicle were on the inner planets, this transmission delay becomes orders of magnitude larger, the problems of control increasingly complex.

For example, it takes radio signals roughly 1.32 sec. to traverse the .25 million mi. between the earth and moon. This amounts to a round-trip transmission delay of 2.64 sec. To this figure may be added the time needed to scan television frames obtained by the TV cameras most companies investigating these vehicles regard as a prime sensor. This time, an inverse function of the rate, may be held low to save transmitter power on the vehicle.

Assume a scan rate which, combined with the round-trip transmission delay to the moon, totals 3 sec. If the roving vehicle travels at 5 mph. (about 7.3 fps.), it could cover about 22 ft. in the time it takes for the command to be issued and the time the operator sees the actual activation of his command, according to Marc Chomet, an engineer with Airborne Instruments. A choice of vehicle speed and scan rate may be balanced against the maximum distance the vehicle might be expected to safely traverse between operator views. Typical speeds considered for proposed roving vehicles run anywhere from 2 to 5 mph.

• **Human factors**—Added to the system delay previously mentioned is the time it will take for the operator to observe unfamiliar lunar terrain and then make his command decision on the basis of information presented on displays. Because of the absence of an atmosphere over the moon, light from the sun and the earth striking the moon is not scattered as it is on earth. The result is sharp contrasts of brightness and darkness, making it especially difficult to see into shadows, differences in shading, etc. This might distort the perception of depth, form and texture, on the moon, Chomet says, causing the operator of a remote roving vehicle to make faulty decisions about size and distance. Operation of the vehicle in lunar daytime only (some missions, particularly those of military reconnaissance may not permit this, however) and with the aid of auxiliary lighting may ease the problem. Shadowed areas might be lighted by remotely controlled mirror or a strobe, synchronously triggered by the television camera frame rate circuitry or singly fired for still-picture presentation. If the operator is not provided with stereoscopic viewing, Chomet points out, he will need to have some idea of the angle of the sun's rays in determining sizes and shapes, distance, angles of terrain depression and inclination.

• **Losing vehicle**—With the difficulties

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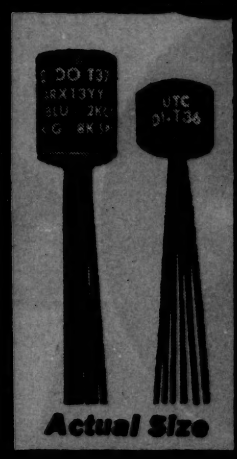

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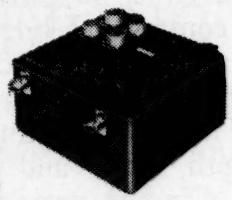

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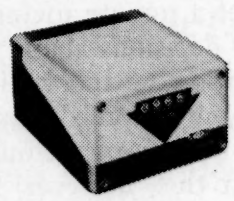

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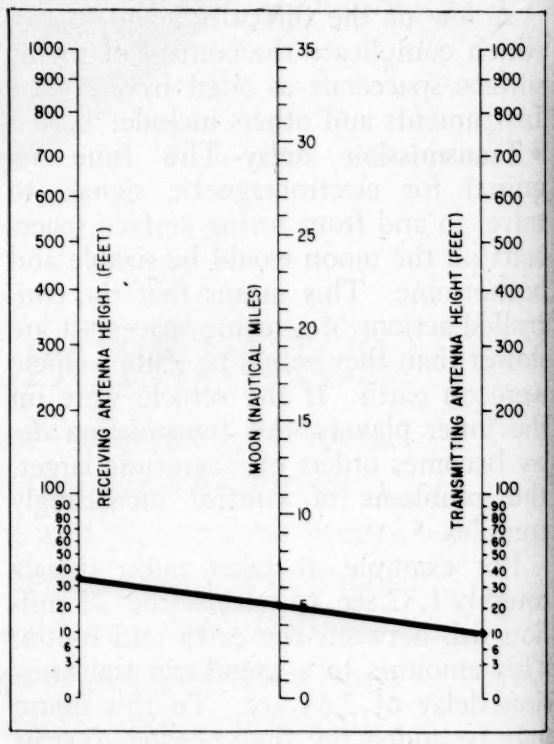
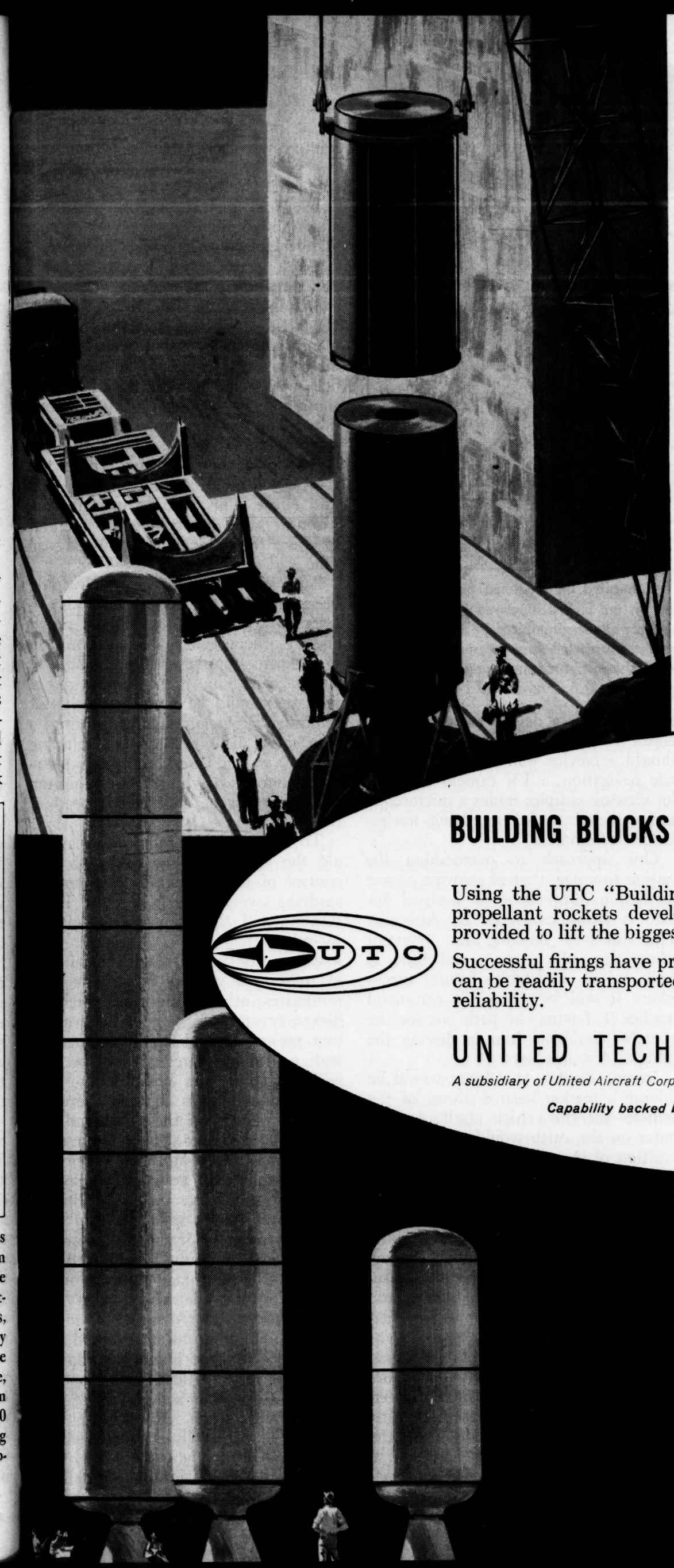
an operator has in judging and interpreting lunar terrain, the vehicle might easily step or roll into a crevice and require new commands to maneuver out of it. If the line-of-sight transmission between it and its earthbound operator thus is broken, the operator may lose and fail to regain command of it.

In its proposed lightweight roving vehicle, Space-General has included an emergency reverse command unit which can cause the vehicle to back up should the operator lose control of the vehicle. The output of the command receiver in the vehicle's telecommunications system is fed to a signal strength monitor before going to the emergency command. If signal strength drops below a predetermined level, the vehicle will back up.

• **Lunar surface communications**—If the roving vehicle is controlled from a stationary or delivery vehicle at the lunar site, a different set of problems may be introduced by the unusual lunar terrain. For example, lunar curvature is greater than that of the earth, more tightly restricting the distance between point-to-point communication antennas on the moon. For a 6-ft. man the line of sight to the horizon is only 1½ mi., Chomet says. For reasonable antenna heights (roughly 20 ft. in each case), line-of-sight distance may be 5 mi. The need to have relays at close intervals might add expense and complexity to the task



CURVATURE of the lunar surface makes distance to the horizon shorter than on earth, thereby more tightly restricting the point-to-point distances between transmitting and receiving antennas of given heights, as shown in this nomogram prepared by Airborne Instruments Laboratory. Sample isopleth indicates that a roving vehicle, which transmits data to earth via a relay on a stationary lunar vehicle, would need a 10 ft. antenna if stationary vehicle receiving antenna were 34 ft. and if rover were to operate up to 5 naut. mi. from relay.



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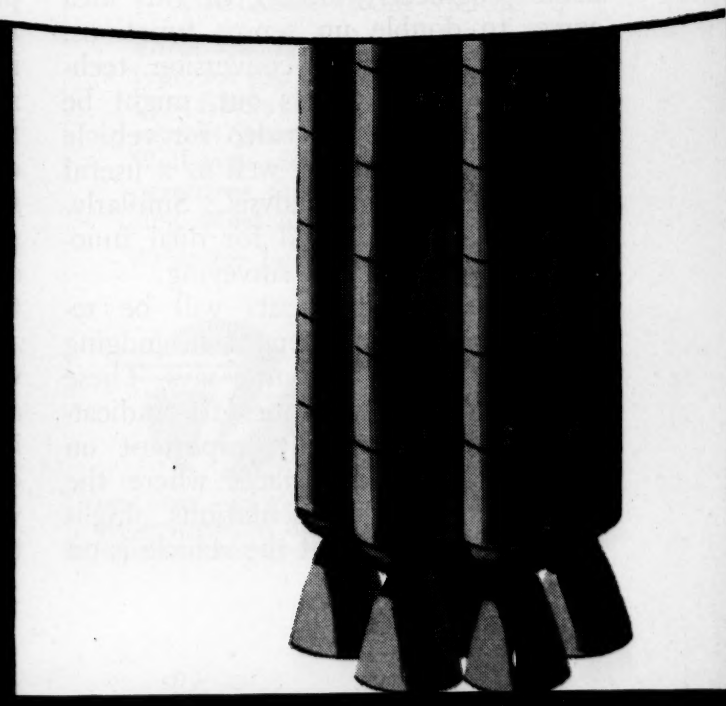
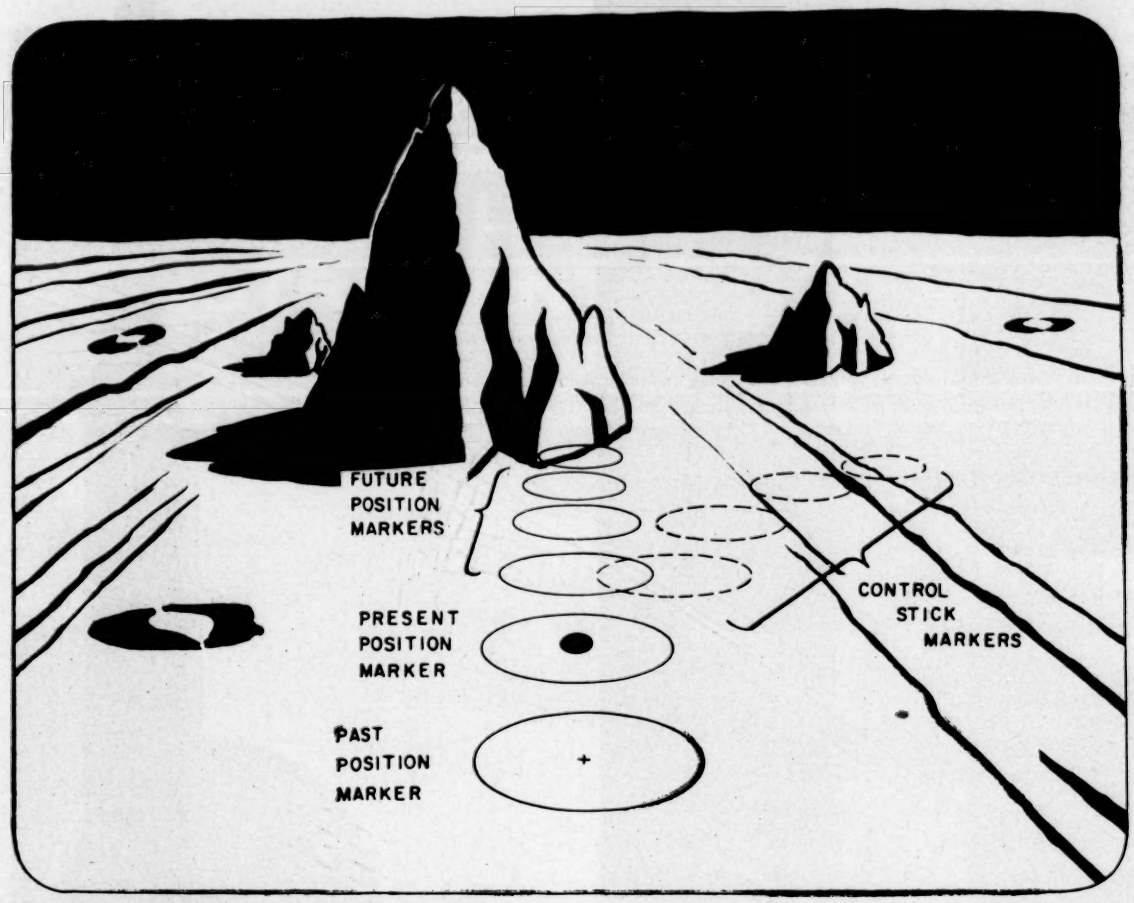




VEHICLE POSITION AND DIRECTION could be indicated on predicted position display in which position of the vehicle at the time the picture is first displayed is shown by a circle with a dot and future positions at one-frame intervals are pinpointed by future position markers. Solid circles (marking the point the vehicle will reach before commanded to alter direction) would replace predicted position circles as the operator issues commands to alter the heading of the roving lunar vehicle.

of maintaining a radio frequency command link between the roving vehicle and lunar base. In addition there is no ionosphere over the moon to shield radio communications from cosmic noise and to serve as a convenient reflector for scatter propagation.

• **Surface navigation**—It may be necessary for the vehicle to locate itself precisely on the moon, especially for purposes of lunar sample return to earth or return to its starting point.

• **Displays**—Because of heavy demands on the operator in interpreting what he sees and making rapid decisions from information supplied to him, considerable ingenuity may be required in display design.

• **Sensors**—Proper choice of sensors for roving vehicles will be influenced strongly by specific vehicle mission requirements, but efforts probably will be made, engineers working in this area agree, to double up sensor functions. Infrared using photo-conversion techniques, Chomet points out, might be a helpful aid to the video for vehicle driving information as well as a useful tool in geological analysis. Similarly, radar might be desired for dual functions of guidance and surveying.

Additional instruments will be required to aid the operator in judging the lunar terrain, Airborne says. These would include techniques for indicating attitude (especially important on gradually inclined surfaces where the operator's video presentations might lead him to think that the vehicle is on level terrain), a device to measure inclines or to stop the roving vehicle should a crevice wall be too steep for safe navigation, a TV camera modified for viewing samples under a microscope and a technique for supplying navigational information.

One approach to overcoming the system time lag, that of showing course prediction information on a visual display is being examined by Airborne. This involves showing the operator where the vehicle is in real time as well as in adjustable future time—where it will be when his command reaches it. Laying the path out for the operator could aid him in driving the vehicle, Airborne says.

In one display, the driver would be driving a marker located ahead of the vehicle—not the vehicle itself. A computer on the earth would calculate the position of the marker and provide signals to be used as commands in ordering the vehicle, provided it does not skid, to follow the marker. A picture from the vehicle reconstituted for the operator on his display would be a lagging presentation while the marker superimposed on the picture would indicate where the vehicle would be when the command is received by it.

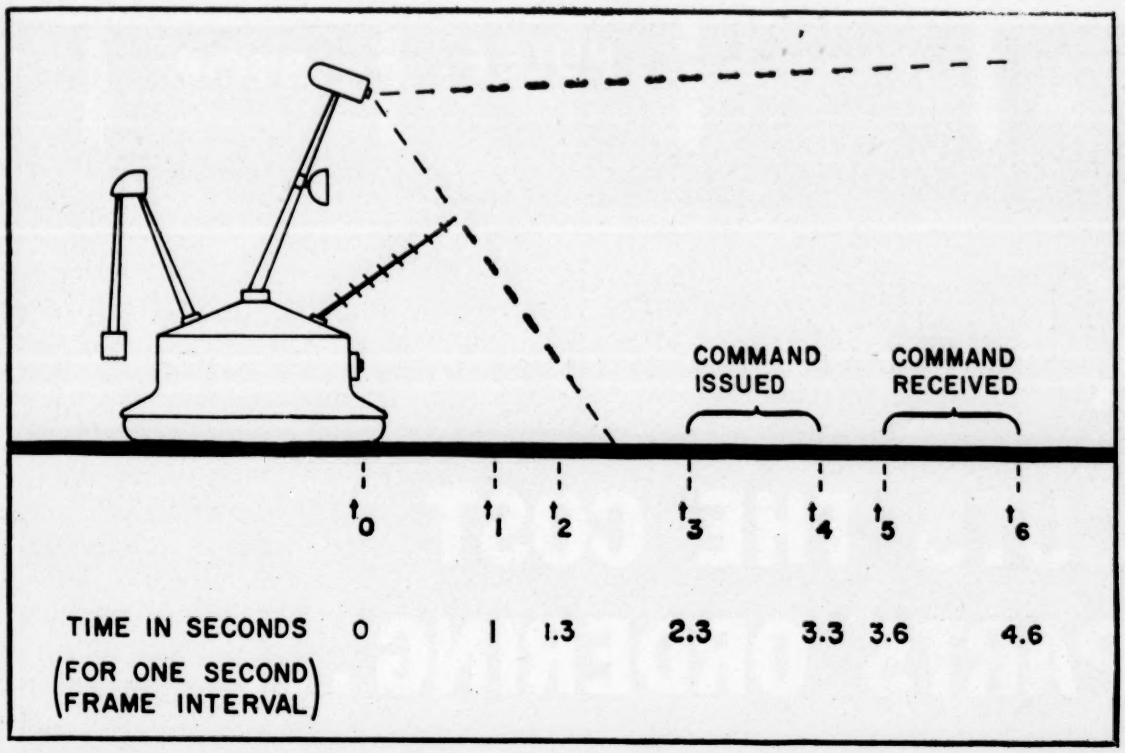
In another method of indicating vehicle position and direction, a picture appears with a series of circles spaced in accordance with the present heading of the vehicle. The position of the vehicle, Airborne explains, at the time the picture being viewed first appeared on the display would be indicated by a dot in the center of one circle. Several circles ahead of this could show future positions of the vehicle at one-frame intervals. A circle behind the one with the dot would locate the vehicle at the previous frame. A freshly transmitted picture is displayed only after it is completely assembled, immediately replacing the preceding picture.

The operator could change the speed and direction of the roving vehicle by adjusting a command stick or sticks. He could check the validity of a command beforehand by observing the predicted position circles. If he were satisfied with the intended results of a command he would execute instructions. The existing group of predicted position circles would disappear, leaving solid circles, showing where the vehicle will be after the command goes into effect. This type of presentation, Airborne says, may enable the operator to drive the vehicle in simulated real time.

Additional information which could be included on the display if simulation tests show they do not obscure vision and are otherwise desirable, are a marker to indicate stopping distances and two curves to describe the minimum radius turn that could be performed without skidding. Vehicle skidding during a turn might be prevented by including in the ground-based computer automatic circuits to limit the minimum radius turn as a function of speed of the vehicle.

To determine satisfactory displays to aid the operator in retaining effective control of roving vehicles, Airborne is studying several possible displays. These displays and their possible advantages include:

• **Video**—For pictures with minimum of noise and with a frame rate that minimizes other annoyances such as flicker, two techniques of successive picture presentation—discrete presentation and continuous presentation by the wipe technique—are under study. The wipe technique cuts the time between taking a picture on the moon and displaying it to the controller because an entire frame need not be constituted before display. The complete frame presentation eliminates image distortion caused by frame split between two markedly different displays. Stereoscopic techniques are being investigated because of the advantage stereo provides in viewing an unfamiliar terrain such as the moon. Stereoscopic photos of barren, unfamiliar terrain viewed monocularly, Airborne points out, do not provide a sense of depth but binocular viewing through a stereo viewer does give strong depth effects. In two-channel binocular vision, each channel acts as a diversity channel for the other. If one fails, visual information is still



LAG EFFECT produced by the time required for radio signals to travel nearly .25 million miles between the moon and earth is illustrated in a drawing indicating the relationship of the lunar vehicle locations at a time the picture observed by the operator is taken (t_0), displayed on earth (t_3) and the command issued to and received by the vehicle.

available from the other. Each channel can be used separately and the binocular viewing system may be used as optical range and height finder.

• **Radar**—Radar may prove valuable in shadowed areas which would be obscure to TV and in judging depth as a backup for stereoscopic vision.

• **Integrated radar-TV** — Combination of radar and TV displays would marry the good angle resolution of TV and high range resolution of radar, the company suggests. A plan position indicator display and a moving marker, and a numerical range indication directly on the video picture, are two possible integrated radar-TV displays.

In the first instance, radar might map a ½ to ¾ mi. radius circular area. This would be held by a storage tube and displayed on operator command, at which time it would replace the usual video picture. The display will show the area as a road map with the vehicle position indicated by a marker. With this display and a range mark overlay, the operator would choose his route between points within the circle or coverage. A similar system, also employing a PPI display, would locate the vehicle in the screen's center and shift the terrain indication to correspond with vehicle motion. The operator can easily find vehicle-to-obstacle range by this approach. Airborne indicates a drawback with this technique is that the vehicle must remain stationary during the transmission of radar information and must secure and add new information every ½ to ¾ mi. This would require a start-and-stop driving technique which is undesirable for reasons of power required, burden on reliability, etc.

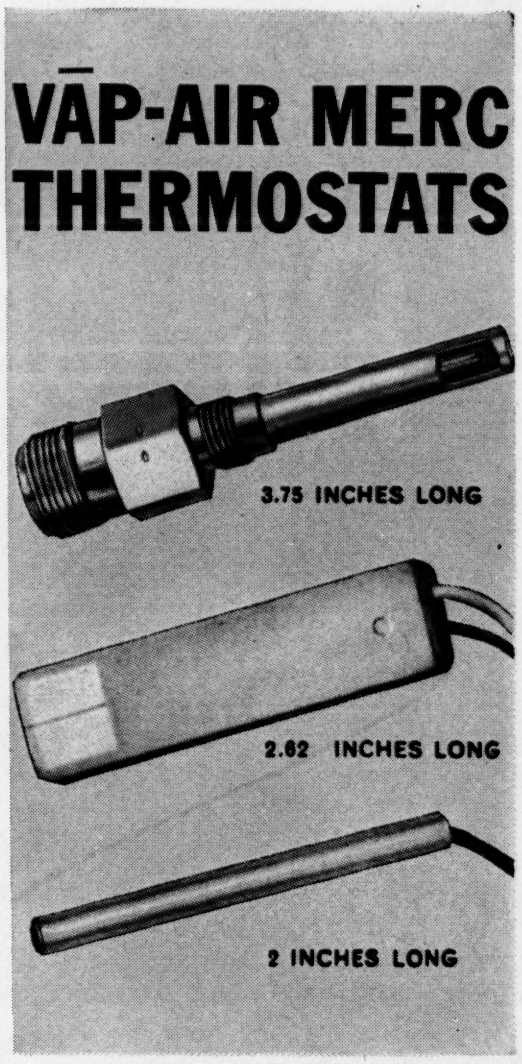
To obtain experience with the problems of a landbound vehicle in an unfamiliar environment, the company is conducting tests with a dual-tracked, electronically powered vehicle simulator carrying a TV camera and operating over a mock lunar landscape.

The little vehicle is 14 in. long, 8 in. wide and 15 in. high and has separate reversible motors for each of its two tracks. It can be moved forward, in reverse, or made to turn by operation of the track mechanisms. Airborne is not suggesting this as a design for a lunar vehicle. This model, a lunar mockup and closed circuit TV, are regarded as techniques of learning about human operator capacity.

A TV camera with a lens providing a 45-deg. cone of vision appears directly in front of the vehicle which moves forward at two speeds and at one in reverse. If a true vehicle corresponding to this model were eight feet in length the model scale speed would be about 5 mph. An operator located in a remote control room guides the vehicle with left- and right-hand control sticks similar to those employed on tracked vehicles. Before him is a 17-in. video display.

Variable control transmission delays can be inserted into the system. Lunar landscape is simulated by a 24 ft. x 15 ft. model containing randomly placed obstacles varying in size from .5 to 5 times the size of the tracked vehicle. Solar illumination is simulated by high-power lamps and adjustments in the brightness and contrast controls.

In one test, in which a 3-sec. delay was introduced, four operators were each required to run the vehicle in the shortest time possible through the mock lunar terrain on 10 separate runs, half with a delay, half without. The con-



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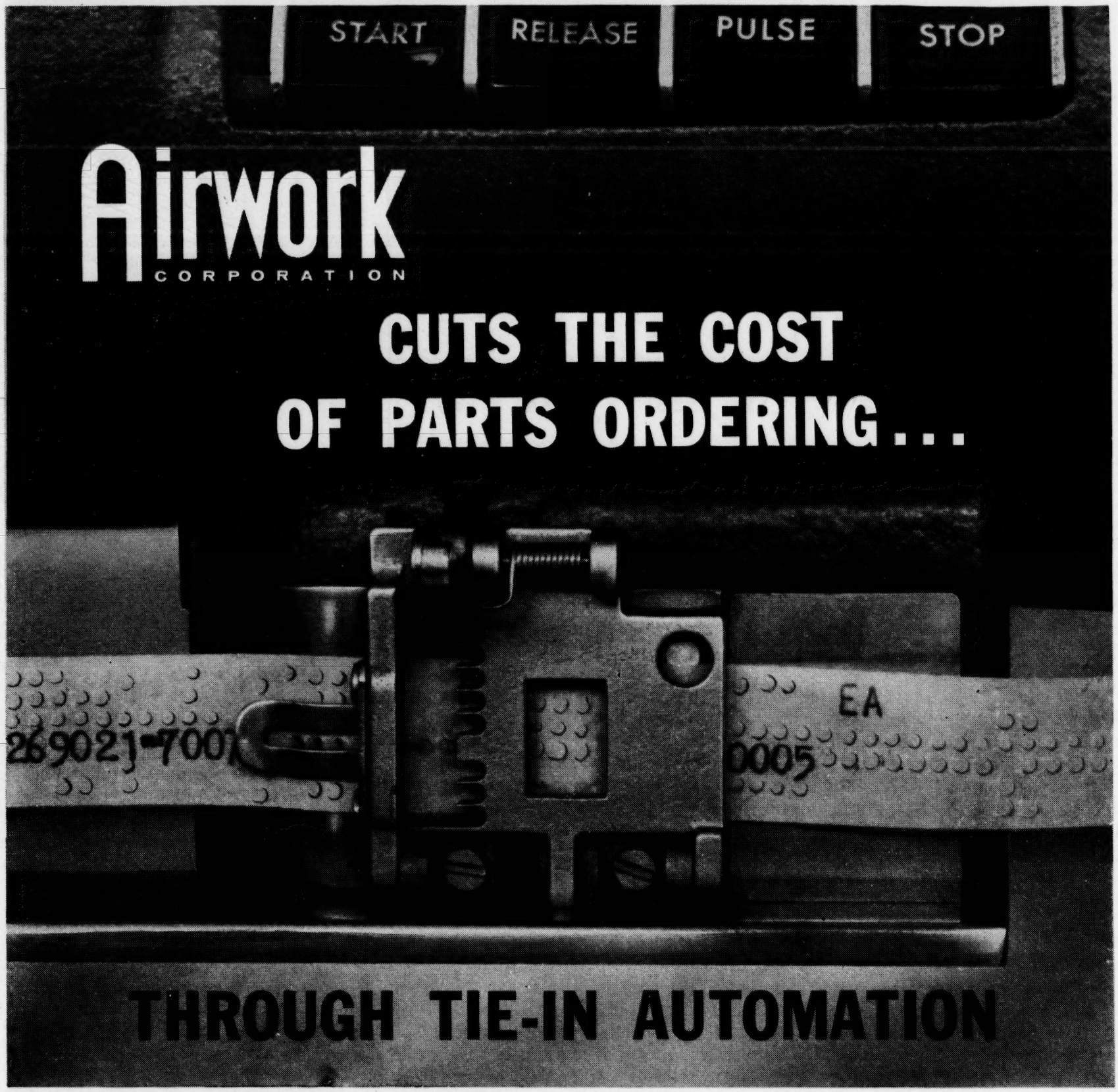

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clusions from the test results are:

• **Brightness contrasts** on terrain affected operator performance as expected.

• **Operators' performance** improved with succeeding runs, suggesting, the company explains, that training and additional information about the terrain will improve operators' control of a roving vehicle.

• **Circumferential display** views may be necessary. The majority of collisions took place with obstacles not in immediate field of vision. The video display did not indicate where the obstacle was in relation to the vehicle after it had passed out of the field of vision of the camera. Wasted motions and needless collisions would result without the circumferential view.

• **Predictor-type** information becomes imperative when time lag is introduced.

• **Orientation** in the unknown environment is difficult to maintain. Orientation aids would be desirable.

Deciding whether to equip the vehicle to transmit data directly to the earth or to its parent craft for relay to earth will depend on a number of factors. These would include amount of power available in the vehicle, its intended parent vehicle, power required for transmission and the transmitting frequency.

If the stationary or parent vehicle were a relay station which would relay the roving vehicles data to earth command center then:

• **Directional antenna** trained on the earth would not be needed by the roving vehicle, relieving it of the need to supply power for antenna orientation equipment.

• **Transmitter power** and primary power consumption can be minimized because the vehicle would be transmitting only about 5 mi. to the stationary relay. If the radius of vehicle operation were to extend beyond 5 mi. from the parent craft, as it probably would for logistic and support missions, then control from the stationary vehicle becomes impractical as additional relays would have to be placed every five miles to maintain the point-to-point communications.

For communications in the other direction, from the earth to the roving vehicle, transmission would be direct as the primary need for the relay on the moon, the need to minimize the power requirements of the mobile vehicle would not be a factor on earth.

Airborne calculates that 3.16 watts would be required for direct transmission from the rover to earth. This assumes operation in the 2,000-mc. range (to utilize NASA's Goldstone, Calif., Deep Space Instrumentation Facility), a 20-db. predetection signal-to-noise ratio, 200-kc. video bandwidth, and single sideband AM modulation, a 1 per sec. frame rate. Reducing frame rate to ½ sec. halves power required.

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20D633-4C	8	26	36 CT	.22 OZ. IN.	6200	2.5W	106,000
20D632-4C	8	26	36 CT	.35 OZ. IN.	6200	3.1W	99,800
20D627-2C	8	115	115/57	.33 OZ. IN.	6200	3.5W	98,000
20D603-2C	11	115	115/57	.60 OZ. IN.	6200	3.5W	43,300
20D603-4C	11	115	36 CT	.60 OZ. IN.	6200	3.5W	43,300
20D590-2A	15	115	115/57	1.3 OZ. IN.	4800	6.2W	27,800
20D612-2C	18	115	115/57	2.3 OZ. IN.	4800	9.1W	31,000

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20D628-2C	8	115	115/57	26	.33 OZ. IN.	6200	.20	.019V	75,800
20D631-4C	8	26	36 CT	26	.35 OZ. IN.	6200	.20	.019V	80,500
20D634-2C	8	26	26	26	.22 OZ. IN.	6200	.20	.019V	75,000
20D634-4C	8	26	36 CT	26	.22 OZ. IN.	6200	.20	.019V	75,000
20D604-2F	11	115	115/57	115	.60 OZ. IN.	6200	.500	.019V	32,600
20D604-4F	11	115	36 CT	115	.60 OZ. IN.	6200	.500	.019V	32,600
20D593-2A	15	115	115/57	115	1.3 OZ. IN.	4800	3.1	.019V	17,500
20D614-2C	18	115	115/57	115	2.3 OZ. IN.	4800	3.1	.019V	25,900

INERTIA DAMPED	FRAME SIZE	VOLTS Ø1	VOLTS Ø2	STALL TORQUE	STALL POWER	SPEED RPM	DAMPING
20D618-2B	8	115	40/20	.30 OZ. IN.	3.5W	6200	40 DYNE CM
20D605-2D	11	115	115/57	.60 OZ. IN.	3.5W	6200	100 DYNE CM
20D613-2C	18	115	115/57	2.3 OZ. IN.	9.1W	4800	750 DYNE CM

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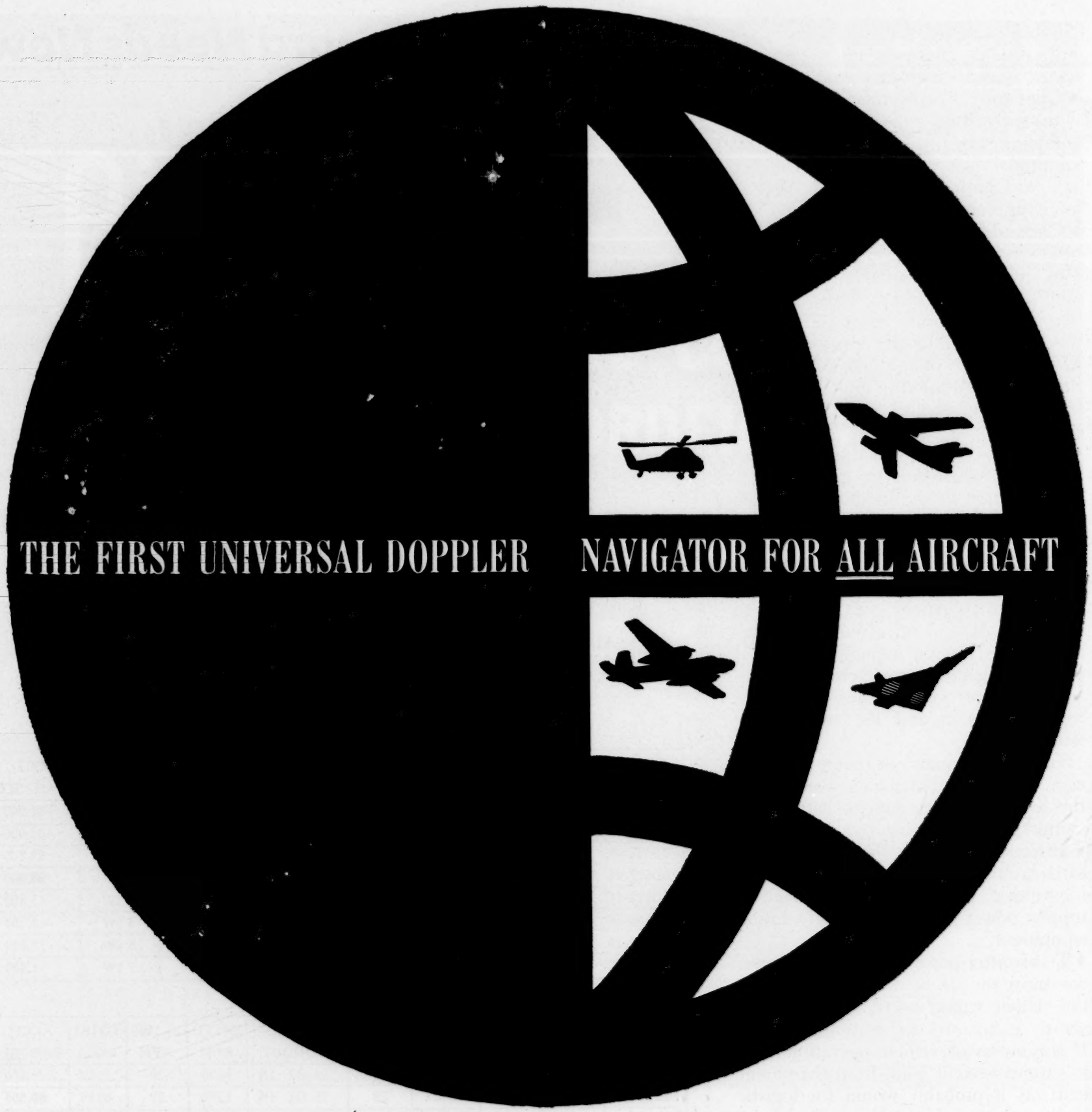

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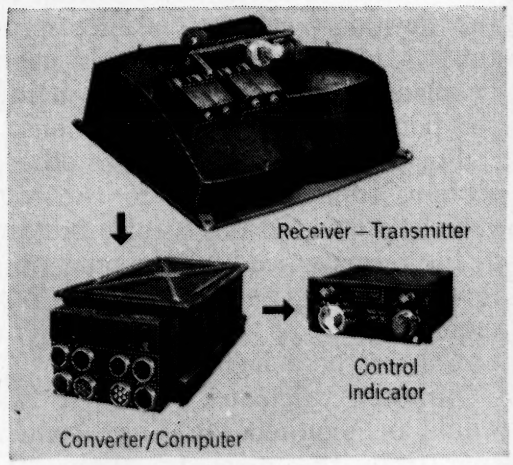

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Lightweight Inertial Unit Cuts Complexity

By Philip J. Klass

Grand Rapids, Mich.—Extremely simple, lightweight inertial guidance system for tactical surface-to-surface missiles, which uses gas-driven gyros and is expected to cost less than $10,000 in quantity production, has been developed here by Lear, Inc.

An experimental model has been delivered recently to the Army Ballistic Missile Agency for laboratory tests and a prototype system is scheduled for delivery by the end of this year.

Based on measured drift rates of about two degrees per hour, Lear engineers calculate that the system can provide CEPs (circular error probability) suitable for medium-range surface-to-surface missiles. The system is intended for use on a roll-stabilized missile which flies a near-ballistic trajectory with aerodynamic control during the terminal phase of the mission.

The system, expected to weigh approximately 30 lb., includes a three-gimbal gyro-stabilized platform, measuring 10 in. dia. × 10½ in. high, mounting two accelerometers, plus a separate package containing control amplifiers and integrators. For an additional 5 to 10 lb., the system could be expanded to include the missile's autopilot and pitch axis programmer, Lear estimates.

The simplicity of the new system stems from the use of gas-driven gyros whose angular momentum is used directly to stabilize the platform instead of the more familiar technique of using the gyros only as a spatial reference to which the platform is slaved by means of servo systems. When a missile carrying the Lear system changes attitude, it causes one of the gyros to precess which in turn generates torques which keep the platform at its original spatial orientation.

This "brute-force" approach eliminates most of the signal pickoffs, torquer motors, coding resolvers, amplifiers and many of the sliprings which are required for the more conventional platform design, according to Robert Flink, platform project engineer.

The gyros in the experimental unit demonstrated here to AVIATION WEEK prior to delivery to ABMA have an angular momentum of about 11 million gm.-cm.^{2}/sec. The prototype model scheduled for delivery later this year will contain gyros with a. momentum of 16 million gm.-cm.^{2}/sec. despite their slightly smaller over-all size.

The gyro wheel is quickly brought up to its 60,000-rpm. speed using cold gas, such as helium. Normally, this would be done just prior to missile launch. After being decoupled from the gas supply, the gyro will coast for about four minutes before losing half of its initial momentum.

Platform Design

The stabilized platform is an inside-out three-gimbal design which provides 360-deg. (unlimited) freedom about the pitch axis and ±30 deg. about roll and yaw axes. The pitch axis is the innermost gimbal, followed by yaw and roll in that order.

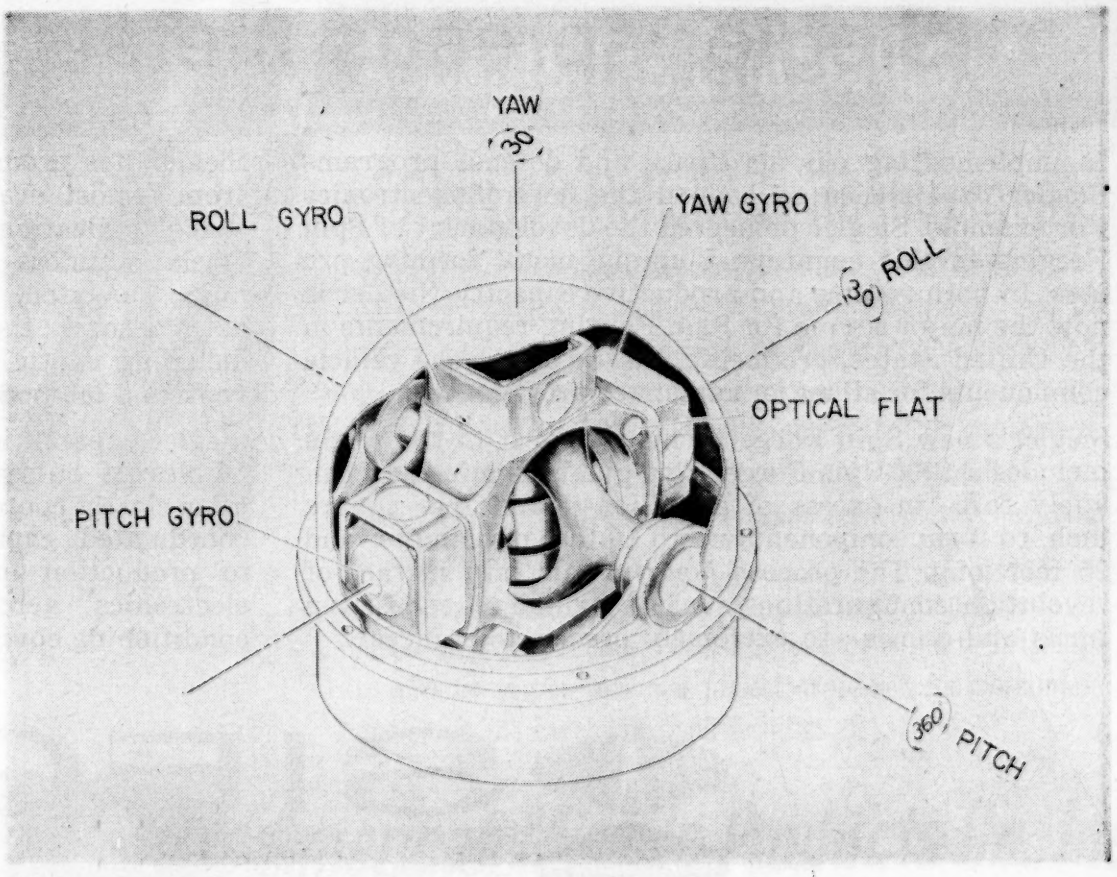
Each of the single-axis gyros is supported in a gimbal that provides ±15 deg. of mechanical freedom. Any spurious torques arising from imperfect gimbal balance or bearing friction will cause the appropriate gyro to precess about its individual gimbal axis as it "absorbs" this spurious torque. This produces no adverse effect on system performance, Lear says, unless the gyro precesses sufficiently to hit its mechanical stop, which is not likely to occur on flights whose duration is less than two minutes, Lear says.

For longer duration flights, the gyro is prevented from hitting its mechanical stops by a simple technique which effectively compensates for spurious gimbal torques. This is done by intentionally causing the gyro to slowly oscillate back and forth through an angle of about six degrees, three degrees either side of its center position. This oscillation, with a period of about 5 to 10 sec., is produced by an a. c. torquer motor, one on each gimbal axis, controlled by a photocell which reverses polarity when the gyro has precessed about three degrees either side of center.

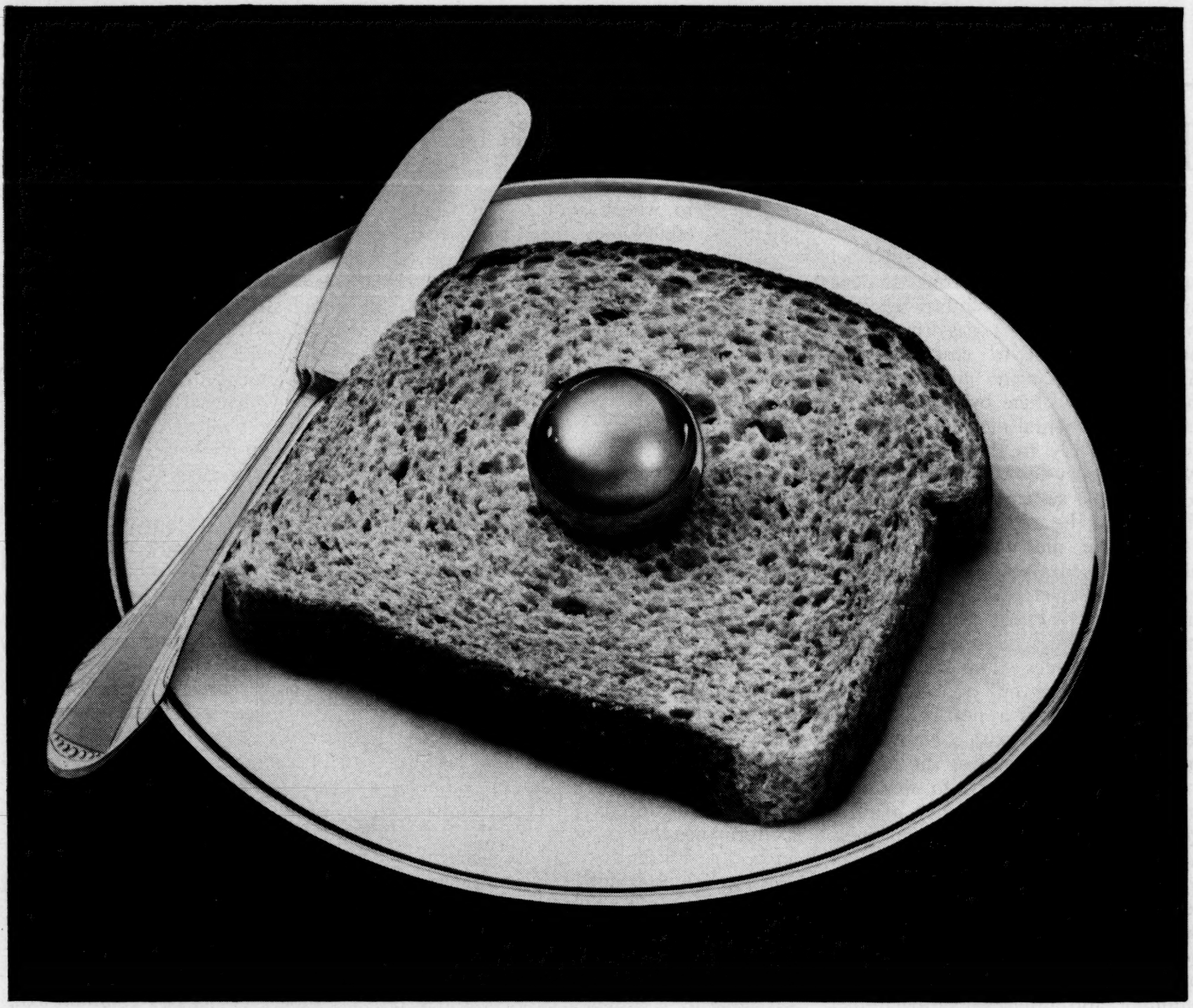
The magnitude of this torque is considerably larger than any spurious torques that would be present from the gimbals, except when the missile flies an erratic trajectory, Lear says. Any such spurious torques add to or subtract from those intentionally produced by the torquer motor, merely causing the gyro to precess more rapidly in one direction than it does in the other.

In operation the three gyros can be seen slowly oscillating back and forth over the limited precession angle while the platform itself remains stationary.

As the gyros begin to run down after being decoupled from the cold gas supply, this deceleration itself generates torques which require compensation. By mounting two of the gyros (pitch and yaw) so their rotors spin in opposite directions about a common axis,



LEAR SYSTEM includes stabilized platform, which contains three single-axis gyros, two accelerometers and employs an inside-out gimbal system. Lear estimates system would cost under $10,000 in quantity production.



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Siegler's new Spin Forge facility, largest in the world, includes a 120″ Spin Forge. This giant machine tool can apply force in excess of a million pounds per square inch, to form components up to 10 feet in diameter and 25 feet long. The process *flows* metals into surface of revolution configurations such as cylinders, cones, venturiis and domes—to extremely precise tolerances.

Siegler has produced various Spin Forged components from almost every known metal used in missile and space applications. These include a wide variety of tool steels, stainless steels, aluminum, Titanium, Molybdenum, Tungsten, Beryllium and Mag-Thorium. Insofar as is known, the process is applicable to all metals, including exotic metals that cannot be formed by conventional methods.

Siegler capabilities in Spin Forging are one of many examples of outstanding Siegler performance, deriving from closest coordination of all Siegler divisions. Siegler coordinated capabilities range from basic research to production in military, industrial and consumer electronics; aerospace components; heating and air conditioning equipment.

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any torque resulting from the deceleration of one rotor will be counteracted by the deceleration torque of the other. To compensate for deceleration torques of the third (roll axis) gyro, Lear uses a torquer motor excited by a fixed voltage proportional to the average deceleration torque.

Prior to application of cold-gas pressure to the gyros, the three gimbals of the platform are caged but the individual gyros are uncaged on their own gimbals. When gas pressure is applied to start up the system, it erects two bellows-type mechanisms which center each gyro until it has come up to speed. When gas pressure is removed, the gyros and the platform are uncaged automatically and ready for operation.

Accelerometer Use Detailed

Present thinking at Lear calls for using an accelerometer of higher accuracy for measuring down-range accelerations along the missile's flight path than the unit used to measure cross-track accelerations.

For down-range measurements, Lear plans to use a floated torque-balancing unit whose pendulum displacement due to acceleration is detected by a photocell that generates a signal proportional to pendulum displacement. This signal is amplified and applied to a torque motor to return the pendulum to center position. The current required to center the pendulum is then proportional to vehicle down-range acceleration.

For measuring cross-track acceleration, Lear uses a non-floated torque-balance unit, produced by Donner Scientific Co., which contains an integral transistor amplifier.

System employs electromechanical integrator (motor-driven tachometer generator) to perform integration for computing vehicle displacement in a down-range direction. The less critical

LIGHTWEIGHT INERTIAL guidance system using gas-driven gyros, developed by Lear for use in surface-to-surface tactical missiles, is now under evaluation by Army Ballistic Missile Agency.

of Ranger's Reliability Requirements

NASA's Jet Propulsion Laboratory chose American Missile Products Co., Inc., a division of Dorsett Electronics, Inc., to play a major part in the design, development, and production of many items of communication and control equipment for the Ranger I and Ranger II spacecraft. This equipment included: telemetry encoders, power switching and logic systems, cosmic ray telescopes, antenna transfer switches, and ground support equipment.

An experienced team of design and production experts at American Missile Products Co., Inc., is ready to put their talents to work for you on your next project. Write now for more information on the capabilities and facilities at:

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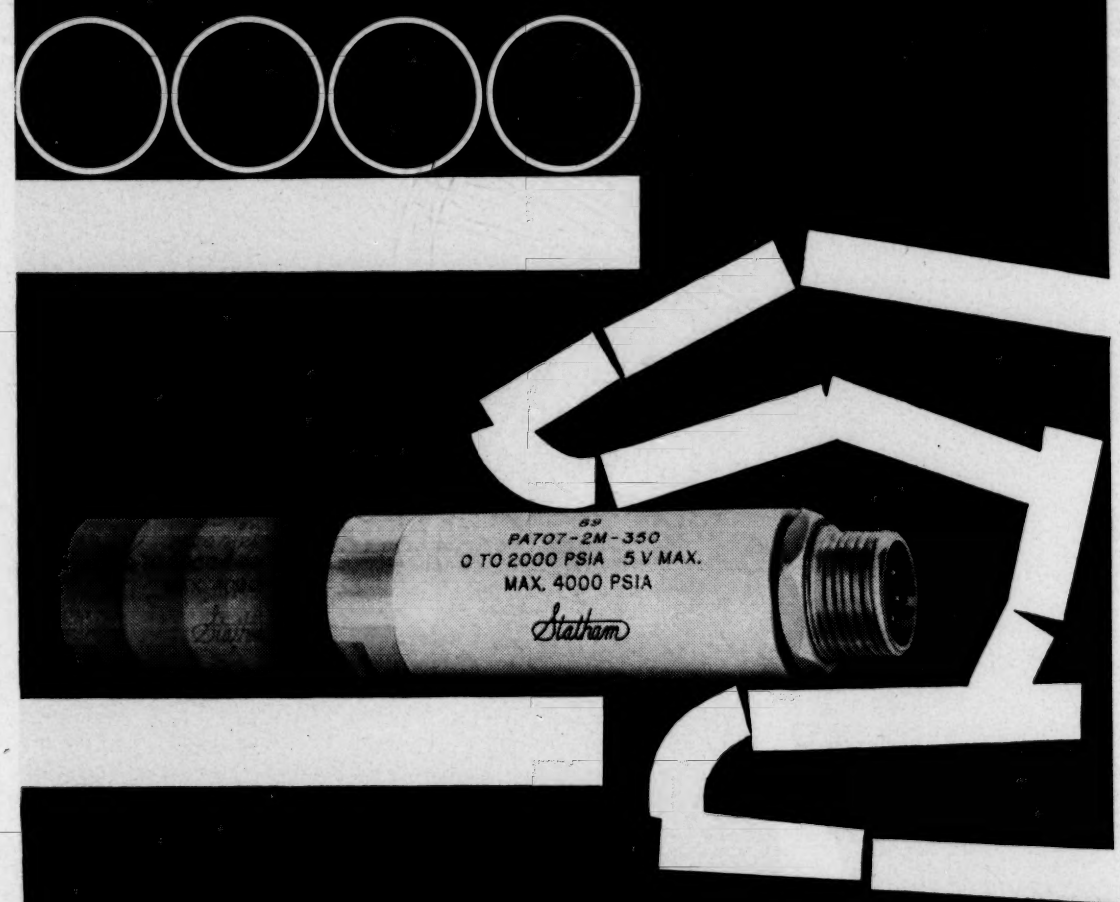

Statham's Multi-purpose P707 Pressure Transducers

Statham's Model P707 series of rugged, general purpose pressure transducers are now available for immediate delivery! The compact, lightweight P707 has been designed to withstand the stringent environmental conditions encountered in high performance aircraft, space probes, and ballistic missiles.

This Zero-length/dimensionless pressure transducer features a wide variety of ranges, low sensitivity to acceleration, and excellent thermal performance without sacrifice in frequency response or in non-linearity and hysteresis characteristics. Available for measurement of absolute and gage pressures from 0-5 psi through 0-5,000 psi.

For complete data on the P707 contact the Statham sales office in your area or write to:

Statham STRAIN GAGE DIVISION

Statham Instruments, Inc., 12401 W. Olympic Blvd.
Los Angeles 64, Calif. / GRanite 8-0361 / TWX: West Los Angeles CAL 6602

cross-track integration is expected to be performed by an all-electronic Miller-type feedback circuit, or an electromechanical integrator with less precise components than the down-range circuit.

FILTER CENTER

▶ **New Trend: Polymorphic Computers**—Development of new techniques for high-speed data transmission over existing telephone landline and microwave facilities is opening the way to a new concept known as the "Polymorphic Computer." This is a collection of digital computers, which can be situated at widely separated locations, which are interconnected to operate, in effect, as a single extremely high-capacity computer. Thompson Ramo Wooldridge, working under Rome Air Development Center sponsorship, is scheduled to demonstrate a polymorphic computer in the near future. International Business Machines Corp. recently demonstrated a magnetic tape transmission unit which permits two computers to exchange data over telephone facilities at rates up to 62,500 characters per second—the maximum speed at which the majority of computers can accept data from magnetic tape.

▶ **Fuel Cell Has High Efficiency**—Thermally regenerative fuel cell, with conversion efficiencies exceeding 50%, has been developed by Armour Research Foundation, Chicago. The new fuel cell uses liquid anodes and cathodes, antimony and tin chloride, circulating through a solid electrolyte. Open circuit voltage is 0.47 v., which drops to 0.3 v. under load. Development was sponsored by the Navy.

▶ **RCA Reports Superconductor Advance**—Mass-production technique for rapid growth of crystalline niobium-tin, a superconducting compound, has been developed by Radio Corporation of America. Process has been used to produce uniform crystal coatings of niobium-tin on fine wire at the rate of 30 ft. per hr., and this figure is expected to be increased greatly with production refinements. Tests performed on coated wire by University of California Lawrence Radiation Laboratory show that it remains superconductive in a 94,000 gauss magnetic field while supporting a current of 7 amp., equivalent to a current density of 100,000 amp. per square centimeter, RCA reports. Technique also can be used to produce hollow tubes of crystalline niobium-tin, the company says.

Class is now in session

Last month, the first group of Air Force student pilots began active training in the supersonic Northrop T-38. In the T-38 they will learn all the skills and techniques of supersonic flight under modern combat conditions. On completing their training schedule, they will be qualified to check out in the most advanced single or multi-jet aircraft in our inventory.

NORTHROP T-38

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THE LAST SALUTE

As the American watched, the German pilot raised up in the rear cockpit of his biplane and saluted smartly. It was his last salute. A split second later an explosion ripped through the fuselage, blowing it into two pieces. With its engine full open, the front section rolled over and raced toward the banks of the Aisne-Marne Canal 14,000 feet below.

It was mid-September, 1915, and the American in his Nieuport XI had witnessed one of the most bizarre accidents of World War I flying.

The action began as Sgt. Bert Hall of Kentucky, fighting in the air service of France, was flying inside the German lines between Rheims and Machault. At about 14,000 feet, Hall was surprised as the German flew above him and tossed the first of several aerial hand grenades. Hall was close enough to see the German pull the fuse pin of his last *Fliegermaus* — and to observe the enemy's wild scramble as he dropped the grenade in his own cockpit. Six seconds later the episode ended.

Hall was flying the "Baby" Nieuport, a biplane powered by an

80-hp. Le Rhone rotary engine to a top speed of 97 mph. at sea level. The little plane could reach its ceiling of 15,000 feet in 41 minutes, but carried fuel for only 2 hours of flying. The Nieuport XI was armed with a single, lightened Lewis gun mounted above the center section to fire above the arc of the prop. The plane was first received by French units late in the summer of 1915. With the help of the D.H.2 it helped master the famous Fokker monoplane.

Called the "Bébé" or the 13-meter Nieuport, the plane had a wing area of about 140 square feet — approximately the size of an Ercoupe and smaller than the modern Cub.

Bert Hall, an almost legendary soldier of fortune, left home in his teens and worked variously as a deckhand, mechanic and auto racing driver before going to France in 1909. There he met the Farmans and learned to fly their early pushers, and he met Bleriot, who taught him to fly a tractor plane.

Before the war he became chief and sole member of the Bulgarian air force, then switched allegiance and headed up the opposing air force of the Sultan of Turkey. Hall was living it up in Paris following a barnstorming tour of Europe when World War I was declared. The next day he joined the French Foreign Legion — the only French armed service that would accept non-citizens.

Hall was a founder of the Lafayette Escadrille, a French squadron made up of American volunteers and activated in April of 1916. By war's end he had scored 20 kills.

The Hall story seems endless. In 1917 he was sent on a mission to Russia and barely escaped with his life. In the late '20s he became known as General Chang Hui-Chang—and he served both the Nanking and Canton governments over a 10-year period. The end came for Bert Hall in 1948. The man who had fought so valiantly abroad died in an automobile accident after suffering a heart attack while on a business trip in the Midwest. He was 68 years old—last of the founders of the Lafayette Escadrille.

Heritage of the Air

One of the most inspiring chapters in the history of technical evolution is the story of the men and flying machines of World War I. It is the highly personalized story of brave men — and the wood, wire, linen and rudimentary technologies that converted manpower to airpower. Today, Leach Corporation celebrates its 41st year in electronics with the presentation of this Heritage of the Air series.

★ ★ ★

Technical Director for Heritage of the Air is Lt. Col. Kimbrough S. Brown, USAF.

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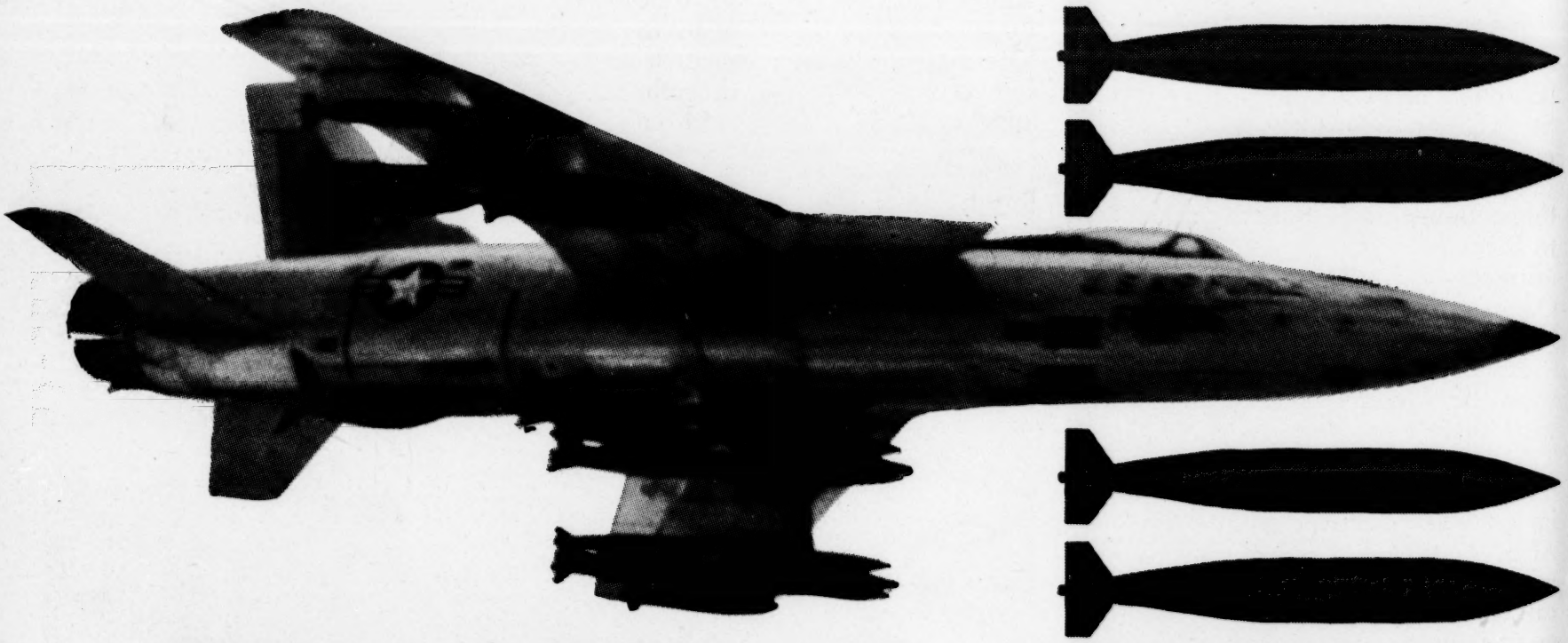
RAF Lightnings Begin Performance At Farnborough

Blurred by the searing blasts of their afterburning Avons, English Electric Lightnings of 74 Squadron, Royal Air Force, roar off the main runway at Farnborough, England, to begin their nine-man acrobatic routine at the SBAC show.



Scrappy infighter with a seven ton punch

August 10, 1961: an F-105 crouched on the runway of Eglin Air Force base. Clutched to its belly and wings were twenty-six 565 pound bombs. Carrying more weight than a Flying Fortress, with no auxiliary assistance, the Thunderchief climbed for the overcast. When the simulated strike was completed, the F-105 had smashed every weight/size record in the logbook. Plus: it can carry 4000 different weapon combinations, including thermo-nuclear. Can qualify for 15 different missions. Can support Army ground troops at 250 mph, can hit the enemy at 1400. Will strike any target, any time, in any weather. Is now with the United States Air Force, here and over Europe.

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SAC Planes Rated on Combat Simulation

By William S. Reed

Fairchild AFB, Wash.—Combat crews participating in the 13th annual bombing competition held here by the Strategic Air Command were composed entirely of Boeing B-52 and B-47 wings.

Crews and aircraft of the Royal Air Force Bomber Command were unable to participate this year because of commitments to the North Atlantic Treaty Organization and the necessity of staying on station.

Also absent from the competition were the Convair B-58 Hustlers along with their crews from Carswell AFB, Tex. and Bunker Hill AFB, Ind.

A repetition of the Hustler's success in last year's competition at Bergstrom AFB, Tex. (AW Oct. 3, 1960, p. 88) was precluded, according to SAC, because the two wings are concentrating on upgrading crews as rapidly as possible to combat-ready status.

No other function, not even participation in the bombing competition, is allowed to interfere with the training schedule.

This year crews were scored for the first time on pilot techniques in the recovery phase of the missions. Points were added to the over-all scores achieved by bomber and tanker crews for reaching an expected approach time within 15 sec., for letdown procedures and for general technique during an ILS approach and landing.

Highest Score

Highest score posted in competition for the Fairchild Trophy awarded to the top bomb wing was 2,172.67 points out of a possible 2,600. The award went to the 4137th Strategic Wing at Robins AFB, Ga., which scored 1,025.7 and 989.8 points for each of its two Boeing B-52 crews and 157.17 points in the munitions loading competition. Highest possible score for a bomber crew was 1,200 points. A maximum of 200 points was possible in the munitions loading competition and was scored on procedures, supervision, reliability, safety and time.

Highest bomber score, 1,025.7 points, was turned in by a B-52 crew commanded by Capt. A. M. Coleman of the 4137th Strategic Wing. B-52s took the first four places in the competition. A total of 24 missions were flown by bomber crews on the two nights of the competition. Six B-47 missions and six B-52 missions were flown on the night of Sept. 17 and the same number on the night of Sept. 19. Bombers were supported by six KC-135s and nine KC-97s on each of the competition nights. Altogether, 54 missions were flown by 54 crews in 27 aircraft.

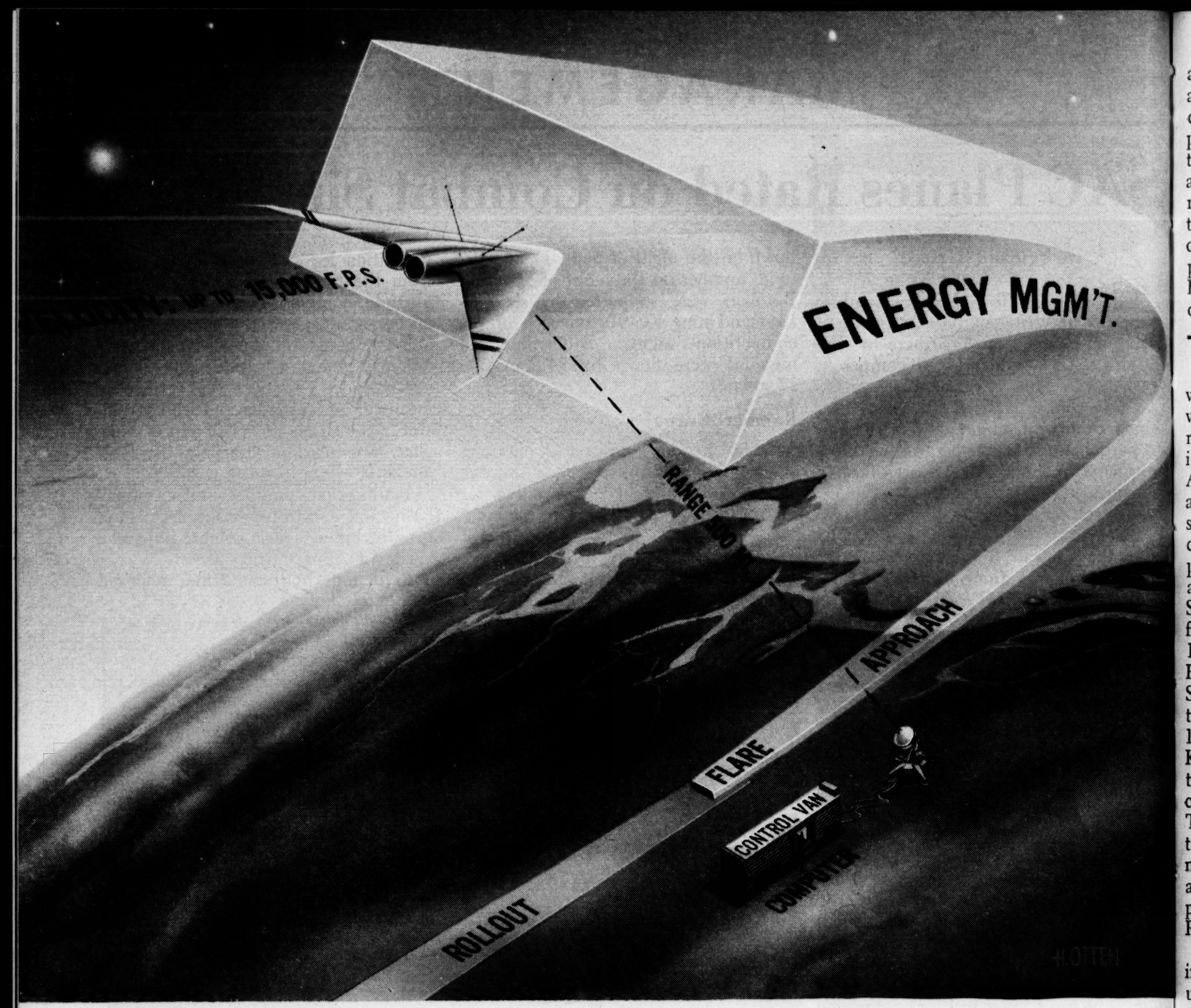
Bomber Crews

Bomber crews were scored on every aspect of their simulated missions, the majority of points being awarded for navigation and bombing. Points were subtracted from scores for each mile of circular error (CE) in hitting a target on a high and a low altitude celestial navigation leg and for the CE in feet from the target on two high and low altitude bombing runs. The CEs on all bombing runs were a matter of feet. Some typical errors on navigation were 4.7 mi. on high altitude and 2.07 on low altitude. Distances were verified by means of ground radar and where available, acquisition radars of Army Nike sites were used for tracking the SAC aircraft.

Points were awarded on a quality basis for electronic countermeasures runs, including a local defense run and a radar simulator run.

Refueling, both the time required

CREW OF A B-52 races for the aircraft during a practice alert prior to the Strategic Air Command bombing competition at Fairchild AFB, Wash., recently. SAC aircraft on ground alert must be capable of being airborne within 15 min. after receiving scramble order. Note wrinkles in skin of B-52 fuselage above wing root of the aircraft. KC-135 tanker aircraft are parked at the end of the alert ramp.



Radio Tracking and Computer Techniques to Return Re-usable Boosters and Space Vehicles

The high kinetic energy of vehicles returning from space and orbital missions creates a problem in energy management. Any system intended to perform such an acquisition and terminal guidance function must have sufficient range and accuracy to pinpoint a vehicle which has re-entered the atmosphere and is still traveling at velocities up to 15,000 f.p.s. This energy must be dissipated, avoiding overheating and overstressing the craft, while the vehicle is safely guided to a normal landing at a designated landing strip.

General Electric Company's Defense Systems Department has an automatic landing system under development which utilizes a precise track radar, a radio-command beacon aboard the vehicle and a digital computer installed in a control van on the ground—all equipment currently in production.

Direct communication with the re-entry vehicle is achieved to maintain a command link for guidance signals and safe energy management. The new landing system is applicable to returning space vehicles and re-usable booster missiles, and is transportable by air or truck. It has been "flight tested" in simulated computer flights and is ready for implementation and application to a specific vehicle. It also will be tailored to the specific vehicle's characteristics.

For further information on how to incorporate radio tracking techniques into your vehicle recovery system write: Defense Systems Department, Dept. DS-100, Syracuse, New York. 170-02

The Defense Systems Department's landing system incorporates the use of: an AN/TP Q-10 Radar, a G-E 225 Digital Computer and Mod IIIG Airborne Transponder and Decoder. Total airborne weight—about 28 lbs.

DEFENSE SYSTEMS DEPARTMENT
A Department of the Defense Electronics Division
GENERAL ELECTRIC
SYRACUSE, NEW YORK

and the quantity of fuel transferred, also figured in the total of points accruable as well as alert procedures—preparation and reaction—and pilot techniques. The score of 1,025.7 points amassed by Coleman and his crew represents a nearly perfect mission from the rigid scoring standpoint. Even the crew with the lowest score in the competition is considered above average, having been a winner in eliminations conducted at its home base.

Tanker Crews

KC-135 and KC-97 tanker crews were subject to similar scoring methods, with the emphasis placed on refueling rendezvous and transfer techniques and in high altitude celestial navigation. Alert procedures and pilot techniques applied to the tanker crews were the same as those for which the bomber crews were scored. Top score of 853 points out of a possible 1,000 was achieved by the 915th Air Refueling Squadron of Ramey AFB, Puerto Rico, flying KC-135s. However, the top KC-135 crew was commanded by Capt. B. T. Napier of the 910th ARS from Seymour Johnson AFB, N. C. Four of the top places out of 12 KC-135 and 18 KC-97 missions were taken by the KC-135s. Average of the scores of the two refueling crews from a base were considered in the award of the Saunders Trophy so that it was not necessarily the top crew which figured in the winning tanker wing. In this case, Napier and his running mate averaged 813 points whereas the winning team from Ramey AFB averaged 853 points.

All phases of the missions flown during the competition were monitored by umpires assigned to a combat evaluation group. At least one umpire rode alone as an observer in each aircraft. Others monitored the crew during the period they were in the assembly area or "tank" to ensure they did not leave or make telephone calls. Monitors also were placed in each hardstand area to prevent unauthorized maintenance beyond the time the aircraft were placed in final readiness or "cocked." Still others occupied GCI sites, GCA trailers, Rapcon centers and other strategic points to monitor all possible phases of the competition.

Takeoffs on each of the two nights commenced sometime after 6 p. m. Precise takeoff times were not announced so that the reaction times of the crews could be checked and the missions made more on the order of a simulated emergency. Scoring was slow because the time to collect data was lengthy and after preliminary scores were posted, crews had the right to protest the score and request that it be submitted for arbitration. Changes frequently were made because of arbitration so that the standings changed, sometimes radically, as protests were submitted to the CEG committee. Only one abort was recorded during the competition—a KC-97 failed to take off on the first night of competition.

Mission Observed

Some insight into the hard work and concentration the crews put into the missions was afforded an AVIATION WEEK writer who rode as observer on one of the KC-97s on the second night of flying, a 6 hr. 30 min. mission covering 1,400 mi. over the states of Washington, Oregon, Idaho and Montana.

The aircraft was KC-97 number 53-0107 commanded by Capt. C. R. McGovern of the 310th Air Refueling Sq. at Schilling AFB, Kan. This crew scored over-all 432.5 points out of a possible 500, placing first among 18 KC-97 crews.

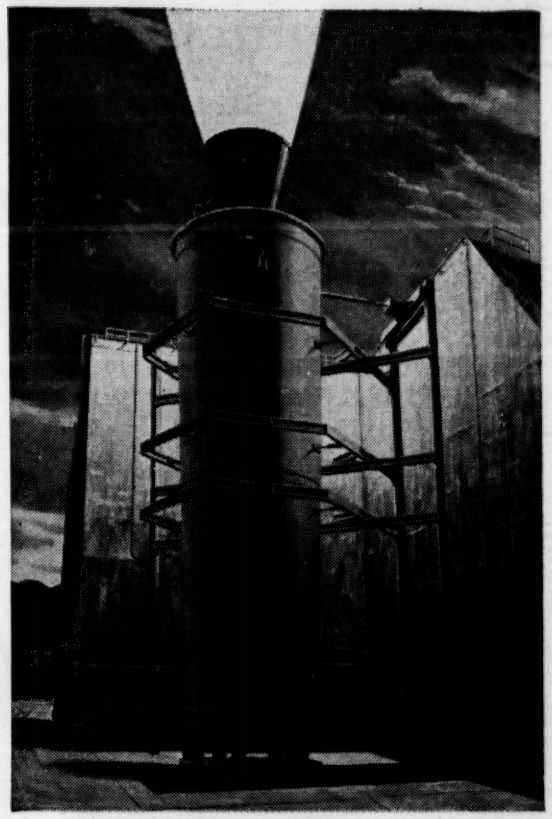
The crew had been allowed 2 hr. for briefing on the mission, the precise routing of which was not revealed until the time of scramble. Briefing time was from 4 to 6 p. m. after which the crew knew only that the scramble klaxon would sound sometime between 6 p. m. and midnight. Earlier in the afternoon, the aircraft had been fueled and preflighted with everything set in the "cocked" condition. The aircraft carried 30,000 lb. of JP-4 for transfer to a receiver aircraft and 33,800 lb. of aviation fuel bringing the takeoff gross weight to 160,000 lb.

Once the aircraft was cocked, no one was allowed to approach it. Umpires stood guard to ensure that the aircraft was not entered until the scramble was given. An exception was made for observers so they could be strapped in and out of the crew's way prior to the alert.

Scramble Ordered

McGovern's crew waited in the tank from the end of briefing until the klaxon sounded and the aircraft commander's name was announced at 8:58 p. m. At the sounding of the alert, the umpire permitted a ground crewman to start an external power cart.

The pilot, copilot, engineer and crew chief scrambled aboard at 9:01 while the navigator and boom operator stood fire guard on either side of the aircraft. The first engine started to turn at 9:03 and the last two crewmen jumped aboard shortly thereafter. Taxi roll commenced at 9:06 with the aircraft being paced by an alert vehicle at a maximum of 25 mph. Because of a remote location, 5 min. was consumed in taxiing out, a condition which would not exist at the home base but was dictated by crowded conditions at Fairchild. Full throttle was applied for a running takeoff at 9:11 p. m., 13 min. after the klaxon started the whole chain of events. The pre-takeoff engine check normally accomplished at the runway's



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PROCESS ENGINEER—For rocket motor processing studies and process methods improvements. Requires chemical engineering degree and direct propellant processing experience.

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end is deleted in the SAC checklist since the crews assume that if the engines checked out earlier in the afternoon they didn't need another lengthy runup when time was of such importance.

The aircraft was headed for a rendezvous with the receiver, a B-52, and climb was commenced to an altitude of 14,500 ft. The mission called for a cell of two KC-97s each to offload 30,000 lb. of fuel to the B-52. This aircraft was leader of the cell and therefore last to transfer fuel. The climb en route to rendezvous with the bomber was completed at 9:44 p. m.

Initial radio contact with the receiver aircraft was established at about 10:20 and from the number one aircraft, the refueling operation between the second KC-97 and the B-52 could be observed. Airspeed during the refueling was 170 kt. IAS with the number two aircraft positioned one half mile abeam of and 00 ft. above the leader. After experiencing some difficulty getting fuel from the second tanker, the B-52 swung into position behind the lead aircraft and refueling proceeded quickly.

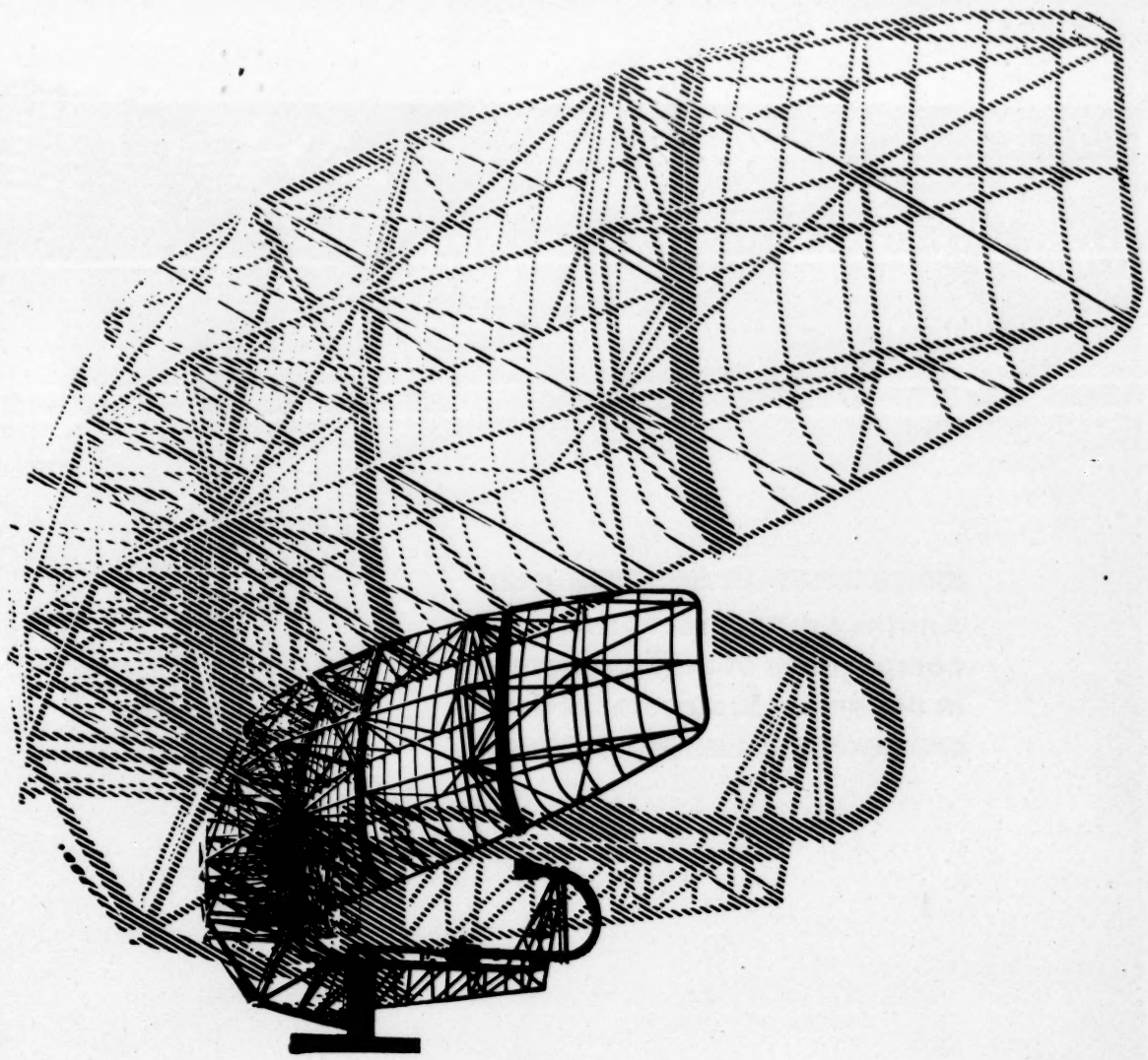
Boom Extended

Within seconds after the B-52 came into view through the boom operator's window, the operator extended the boom and successfully made contact with the bomber. Although some variation in position was observed during the operation, a disconnect did not occur and the full amount of 30,000 lb. of fuel was transferred in short order. From the time the B-52 came into position at 11:09, only 5 min. elapsed until it was on its way with 30,000 lb. more of fuel. An unusual phenomena was noted during the refueling operation in that the noise from the B-52's right jet engines could be heard clearly in the KC-97, rising and falling as power was changed to maintain formation.

A three-hour navigation leg was started at 11:40 p. m. terminating in the vicinity of Seattle, Wash., at 2:45 m. This portion of the flight was conducted at 16,000 ft. at a true airspeed of 225 kt. with the only means of navigation used being celestial fixes. Error on the navigation leg was only 5 naut. mi. as scored by ground radar sites. The crew received 137.5 out of a possible 140 points for navigation.

Return trip to Fairchild AFB was included at 16,000 ft. and after a letdown, holding procedure and an ILS approach, all of which were graded by both the umpire aboard the aircraft and scored by ground radar, the flight ended at 3:39 p. m.

Despite the late hour, the crew went immediately to the scoring center after maintenance briefing to await the scores even though it took nearly 12 hr. before even preliminary scores were posted.



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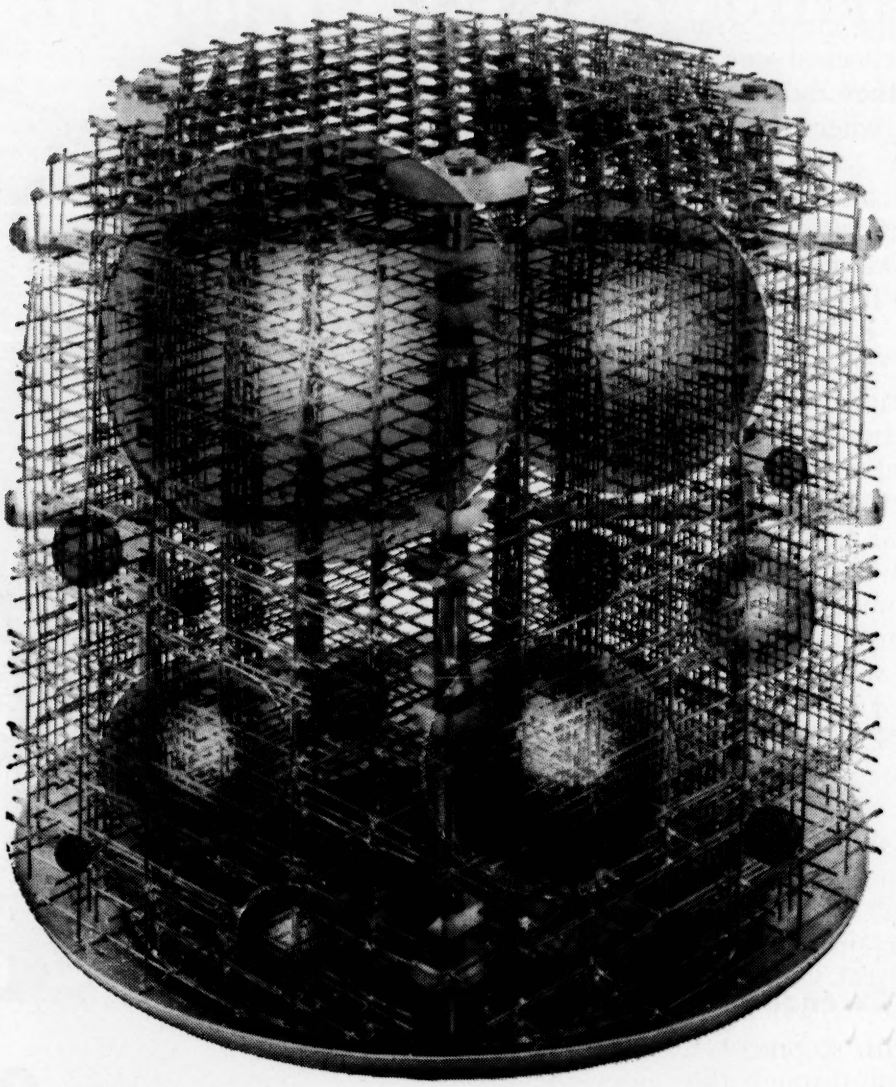

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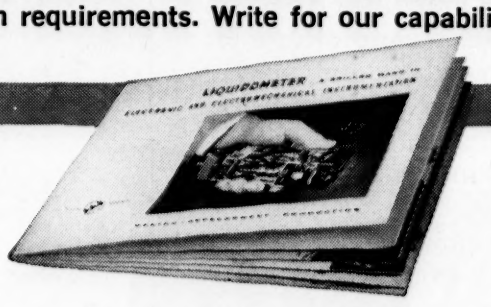

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PRODUCTION BRIEFING

Application of a honeycomb sandwich material in solid fuel rocket motor cases for high-strength, light weight characteristics is being studied by North American Aviation's Space and Information Systems Division, Downey, Calif., under contract with Air Force's Aeronautical Systems Division. NAA will conduct feasibility study and construct and test sub-scale and full-scale models.

Space Technology Laboratories, Inc., has received three new contracts totaling $177,000 from the National Aeronautics and Space Administration's George C. Marshall Space Flight Center. One contract is for developing formulas for estimating cost of space vehicles in the Saturn to Nova range, having liquid-fueled, recoverable first stages and nuclear-powered upper stages. Second contract is for comparing merits of assembling and checking Saturn and Nova class vehicles in vertical and horizontal positions. Third contract relates to study of control and dynamic stability problems expected in operating Saturn and other heavy space vehicles and in the development of a minimum-complexity control system.

Weber Aircraft Corp., Burbank, Calif., will design and manufacture the ejection seat and survival system for the Dyna-Soar manned space glider under a contract approximating $600,000 from The Boeing Co.

J. W. Fecker Division of American Optical Co., Southbridge, Mass., has received a $1,077,404 contract to develop two tracking optical telescopes for USAF's Mobile Atlantic Range Station. Telescopes will be mounted aboard two ships which are being converted into floating observation stations along the Atlantic Missile Range. The instruments will be used to photograph reentry of missiles and space vehicles.

Corps of Engineers has awarded an $88,551 contract to Bacin Construction Co., Port Canaveral, Fla., for construction of a 1,450-sq.-ft. building to store test equipment for Minuteman ICBM test facilities at Cape Canaveral. Contract also calls for additions to two existing buildings for use as receiving and inspection structures.

Arthur Venneri Co. of Washington, D. C., has received a $2.5-million contract from National Aeronautics and Space Administration's Goddard Space Flight Center for construction of the center's eighth of 10 major structures—a Satellites Systems Building—on a 550-acre site near Greenbelt, Md.

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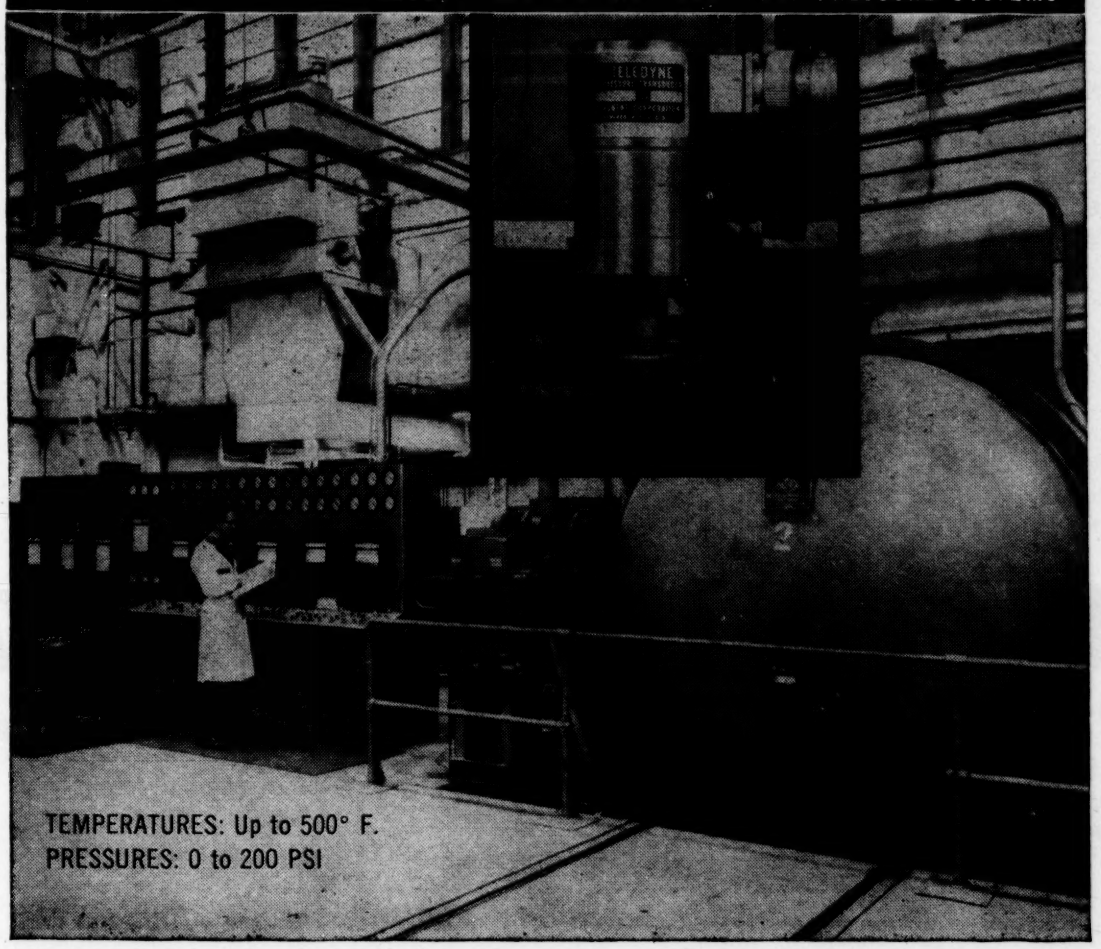
TELE-NEWS

ABOUT TELEDYNE AND TELEFLIGHT PRESSURE SYSTEMS



Taber Transducer keeps close tab on autoclave air pressures at Twin Coach

The dependability and accuracy of Taber Bonded Strain Gage Pressure Transducers are pointed up in the manufacture of bonded aircraft assemblies at Twin Coach Co., Buffalo, N. Y.

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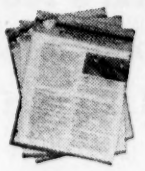

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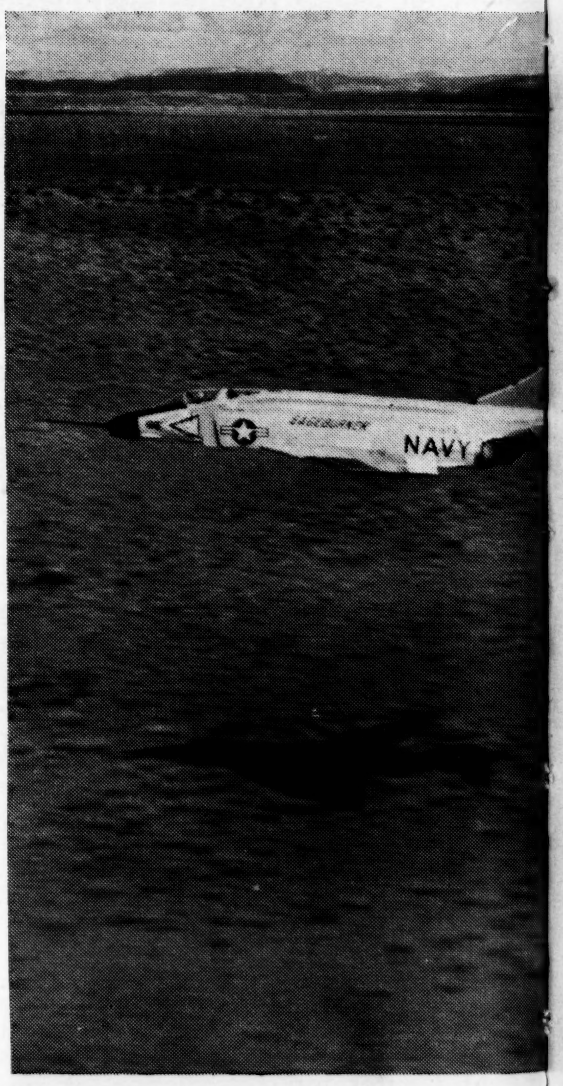

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CAB Accident Investigation Report:

Icing Caused Capital Viscount to Crash

At approximately 2219 E.S.T., January 18, 1960, a Capital Airlines Viscount, N 7462, en route from Washington, D.C., to Norfolk, Virginia, crashed and burned near Charles City, Virginia. All 46 passengers, including two infants, and the four crew members received fatal injuries.

N 7462 crashed in a wooded area, striking the ground in a level attitude with no forward velocity.

The Board believes the accident was caused by the delayed arming of the engine ice-protection systems while flying through icing conditions, causing eventual flameout of the four engines. This condition existed for sufficient time to cause a drop in battery electrical energy, preventing the unfeathering and relighting of sufficient engines to maintain flight. The aircraft was then dived in an effort to attain sufficient airspeed to drive the propellers out of the feathered positions by windmilling. At the same time, multiple attempts were made to relight one or more engines. Successful relights were either interrupted by auto-feather action initiated by premature advancing of the throttles prior to complete light up of an engine or prevented by insufficient battery electrical energy. No. 4 engine was eventually relit and the crew had just successfully relit No. 3 engine when the aircraft crashed.

As a result of this accident, Capital Airlines dropped the phrase "descend to warmer climate for relight" from its emergency checklist and instructed its Viscount pilots that relight could be accomplished at any altitude if proper drill were followed. Capital Airlines also adopted a system of checking pilots to ascertain that they had the benefit of the latest operating information.

Investigation

Capital Airlines Flight 20 of January 18, 1960, originated at Chicago Midway Airport and was to terminate at Norfolk, Virginia, with a stop at Washington, D. C. On this particular flight there was an aircraft change at Washington, D. C., at which time Viscount N 7462 was substituted for the original equipment. The assigned crew for Flight 20 consisted of Captain James B. Fornasero, First Officer Philip H. Cullom, Jr., and Hostesses Diane M. O'Donnell and Brigitte F. H. Jordt. There were 46 passengers aboard, including two infants.

At the time of dispatch, N 7462 had a basic operating weight of 40,155 pounds. The manifest shows 1,047 pounds of cargo, 44 passengers for 7,260 pounds, 401 pounds of water methanol, and 12,000 pounds of fuel for a total gross weight at takeoff of 60,863 pounds. It should have been 61,083 pounds due to the additional stewardess and company mail. The maximum takeoff gross weight for runway 18/36 at Washington National Airport is 64,500 pounds. The maximum takeoff gross weight for landing at Norfolk is 60,945 pounds.

The crew was briefed on the weather by the company dispatcher prior to departure.

Flight 20 departed the Washington National Terminal at 2130[1], and taxied to the runup block for runway 36. At 2135, the flight received its IFR clearance which read: "Capital 20 cleared to the Norfolk Airport via direct Springfield, Victor 3 to Brooke VOR, flight plan route, maintain 5,000 feet, cross Springfield at 3,000, maintain 3,000 feet until two minutes past Springfield, cross Brooke at 5,000."

Flight 20 took off at 2140 and immediately switched to departure control frequency. There were no major discrepancies in the dispatching, loading or takeoff of the aircraft.

The flight proceeded to Springfield under departure control radar and switched to the Washington Air Route Traffic Control (ARTC) frequency when over Springfield. The Washington ARTC Center cleared the aircraft to climb to and maintain 8,000 feet.

Subsequently, Flight 20's clearance was amended to proceed via Victor 3 Brooke, Victor 286 Tappahannock, Victor 213 Hopewell, direct Norfolk, maintain 8,000 feet. The flight reported passing Brooke VOR at 2153 and estimated Tappahannock at 2202. Radar service was terminated at Brooke VOR, and the flight was requested to monitor Washington ARTC Center frequency until reaching Tappahannock, where it was to contact the Norfolk ARTC Center.

Flight 20 reported to Norfolk Center when over the Tappahannock low frequency range at 2201, at 8,000 feet, and estimated Hopewell VOR at 2212. At approximately 2205, four minutes past Tappahannock, the following clearance was issued to Capital Flight 20: "Capital 20 cleared to the Norfolk ILS Outer Marker from over Tappahannock, Victor Airway 213 Hopewell, then via the Hopewell 140 degree radial to Deep Creek, direct to the Norfolk Outer Marker, to maintain 8,000, contact Norfolk Radar on frequency 118.5 over Hopewell." The crew's acknowledgement of this clearance was the last radio contact with Capital Flight 20. All radio communications were normal, the pilot was making good his calculated groundspeed up to this time, and there was no indication of any difficulties.

Witnesses stated a low-flying aircraft executed two circles in a left pattern within a two-mile area of the impact site just prior to the time of the accident. The circles were made at increasingly lower altitudes. Many witnesses believed the aircraft was experiencing some type of engine difficulty. Application and removal of power, or cutting on and off of the engines, occurred at least three times. There was a final roar of power just before impact which occurred at approximately 2219.

[1]All times herein are Eastern Standard based on the 24-hour clock.

Wreckage Area

The wreckage area was located 8.4 nautical miles on a bearing of 067 degrees from the Hopewell VOR station. This is a point approximately 6.3 nautical miles east of the centerline of Victor 213 airway.

The wreckage was confined to the immediate area of impact, and no damage to the trees in the surrounding area could be found. All trees that did show impact damage were within the normal dimensions of the aircraft.

The aircraft struck the ground on a heading of 182 degrees magnetic, wings approximately level, and in a pitch attitude of about eight degrees noseup.

The wreckage was impaled on five trees, two through each wing and one through the tail cone. Sixty to 75-foot high trees also bracketed the nose, wings, and tail. Most of these trees showed no impact marks.

Shortly after impact, fire consumed the wreckage and caused considerable damage from the nose to the rear pressure bulkhead, as well as through the center wing section to just outboard of Nos. 1 and 4 engines.

There was no evidence of any structural failure prior to impact, and all wing failures and separations were due to ground conformity of the structures from impact and damage by intense and prolonged heat. All structure was accounted for at the wreckage. There was no evidence of in-flight fire.

The primary flight control surfaces were in good condition and operable, although damaged by heat and impact. The gust locks were found in the "OFF" position. The primary flight control systems, insofar as they could be checked, were also in good condition with no signs of damage or malfunction prior to impact. These systems were traced and inspected completely from the control surfaces to the center section spar. Fire damage prevented a complete examination forward of the spar; however, the critical areas, such as rod-end clevis fittings, were examined forward to station No. 92, where continuity was lost.

The trim tabs were set for: aileron-neutral; elevator-one degree nose-up; rudder-three degrees nose-right.

The landing gear, flaps, and landing lights were in the retracted positions.

The inter-engine and crossfeed fuel valves were closed. The surface anti-icing system was off at both heat sources.

The No. 2 main and Nesa inverters

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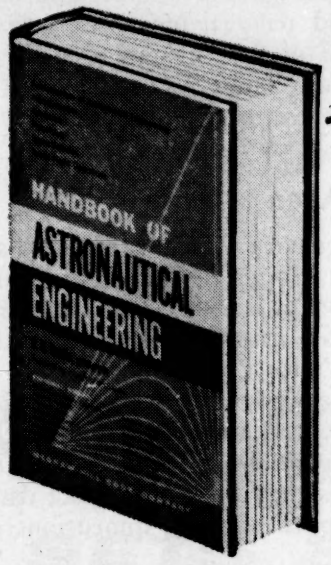

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showed evidence of rotation at impact. The No. 1 and emergency inverters showed no rotational impact marks.

Most of the propeller blades of each propeller were bent in various directions or missing from the hub. Nos. 1 and 2 propellers had a similar pattern of relatively light damage. Nos. 3 and 4 propellers suffered more severe blade distortion. No. 4 propeller blade root fixing was more severely damaged than that of No. 3 propeller. The positions of the propeller operating pistons indicated propeller settings as follows: No. 1 propeller—on feather-stop position of 84 degrees, 24 minutes; No. 2 propeller—on feather-stop position of 84 degrees, 24 minutes; No. 3 propeller—on flight-fine-stop position of 24 degrees; and No. 4 propeller —slightly above the flight-fine-stop position at 26 degrees.

Damage Variations

All four powerplants were partially or completely buried in mud or water and were found in their correct positions in relation to the wing. Investigation revealed significant differences in the damage to engines Nos. 1 and 2, as compared with damage to engines Nos. 3 and 4. Engines Nos. 1 and 2 had few impact rotational rub marks appearing on the turbine and compressor assemblies. There were no bent or displaced vanes on the first and second stage impellers of these engines. However, these engines did have static press marks on reduction gearing made at impact by the transfer housing retaining studs. Impact damage occurring in the compressor sections of these engines was very light, and the eye casings were not damaged by rotational forces. The torsion shafts of the compressors had not failed.

Investigation of Nos. 3 and 4 engines revealed significant radial rub marks on reduction gearing and transfer housing retaining studs. The impact damage occurring in the compressor sections of these engines was very heavy. The impellers had some rotational damage. The eye casings had been rubbed by the rotating guide vanes. Both torsion shafts and both second stage impeller shafts had failed. There was also evidence of radial rub marks on the face of the turbine disks, and metal spatter was present on the nozzle guide vanes and turbine blades of Nos. 3 and 4 engines.

The hot-air gate valves for the four engines were found in closed position.

At 1900, January 18, 1960, there was a low pressure center at the surface over eastern Michigan and the Lake Erie area. A broad flat trough extended from the low center southeastward to a developing low over southeastern Virginia. A cold front extended from just north of Raleigh, North Carolina, to Tampa, Florida, while a warm front had moved northward along the coast to a position along the Virginia-North Carolina border. By 2200, the cold front was located between Blackstone and Norfolk, Virginia, while a deepening low was centered about 100 miles east of Delaware Bay with a trough extending back to southeastern Virginia.

The pertinent aviation area forecast prepared by the U. S. Weather Bureau and valid at the time of the accident called for obscured sky conditions with ceilings between 100 and 400 feet and visibilities ranging from ⅛ to two miles in light drizzle and fog over Virginia, eastern Maryland, Delaware, and northeastern North Carolina, with conditions slowly improving from the southwest after midnight. The forecast also indicated a chance of a few thunderstorms over the coastal waters of southeastern Virginia and eastern North Carolina until midnight.

The freezing level was forecast to be between 4,000 and 5,000 feet over eastern West Virginia, and sloping to 8,000 to 9,000 feet over eastern North Carolina, and lowering to the surface over eastern West Virginia and western Maryland by midnight. Moderate to heavy icing in the clouds was expected in the vicinity of a developing low over the coastal waters of southeastern Virginia and eastern North Carolina. Light to moderate icing (predominantly rime) in clouds above the freezing level was forecast for eastern West Virginia, western Maryland, and the mountainous sections of Virginia.

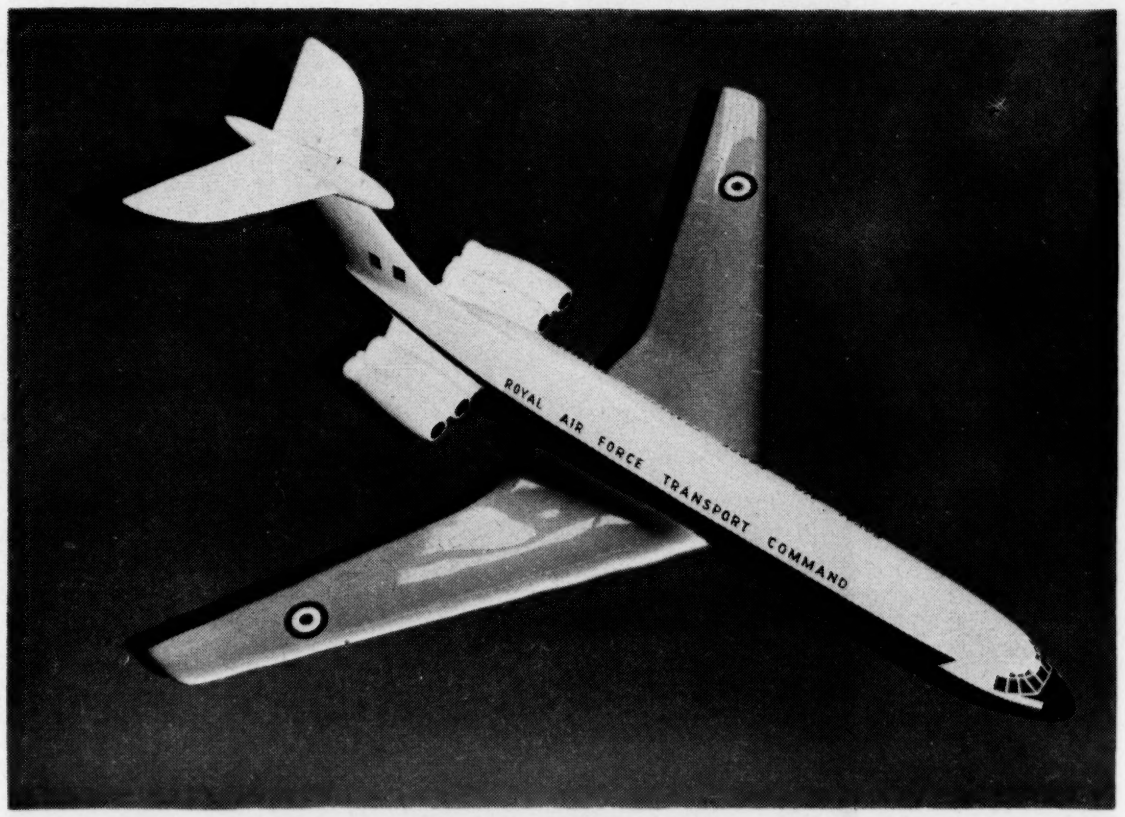
Upon departure of N 7462 from Washington National Airport, the local weather was reported as: measured 600 feet broken, 7,000 feet overcast; visibility five miles in fog. Ground stations nearest the proposed route reported ceilings ranging mostly from 100 to 400 feet and visibilities from five miles to less than one mile in light rain or drizzle and fog. Conditions at Richmond during the flight changed very little with the ceilings measured at 200 feet and the visibility two miles in light rain and fog. Conditions at Norfolk were improving. At 2131, Norfolk reported an estimated ceiling of 700 feet broken, 6,000 feet overcast; visibility four miles in fog. At 2231, there were scattered clouds at 700 feet and 1,600 feet, and an overcast at 6,000 feet with visibility of six miles in fog.

Available pilot reports and radar reports indicated that cloud tops between Washington and the accident site were between 10,000 and 13,000 feet. The pilot reports showed layered clouds on the route with the base of the upper layer about 6,000 feet, and the tops of the lower layer between 3,000 to 4,000 feet. A few of the available pilot reports indicated mostly light to moderate turbulence over central and southern Virginia. There was one report of moderate to heavy turbulence at 6,000 feet over Salisbury, Maryland, at 2144, and a report of moderate to severe turbulence at 5,000 feet, just south of Lawrenceville, Virginia, at approximately 2045. Heavy rain showers were reported in flight between Richmond and Lawrenceville, while severe turbulence was reported in the vicinity of Langley Air Force Base about 2230. A pilot letting down into Norfolk, Virginia, about 2230 reported turbulence, heavy rain, and short periods of hail. Moderate to heavy rain showers were observed by groundwitnesses in the general area of the accident site about one to two hours prior to the accident. These groundwitnesses indicated, however, that at the time of the accident there were, at most, scattered light showers in the area, while some sections were affected by fog, which occasionally was heavy enough to produce light drizzle. Little or no wind was reported, and thunderstorms had not occurred at any time during the evening.

Groundwitnesses in the Yorktown-Newport News, Virginia, area reported high gusty winds, heavy rain showers, hail, and possible thunder at about 2220 to 2230.

Flash Advisory

Flash Advisory No. 6 issued at 1700 January 18, at Washington, D. C., and valid from 1820 to 2210, indicated increasing shower and thunderstorm activity over Virginia and North Carolina coastal sections and adjacent waters with severe turbulence and hail aloft, and moderate to heavy icing



Royal Air Force to Get VC.10s

Vickers VC.10, powered by four Rolls-Royce Conway Rco.42 bypass engines, is shown in model form bearing Royal Air Force markings (AW Sept. 11, p. 37). The RAF transport Command has ordered five VC.10s. First aircraft for the British Overseas Airways Corp. is on the production line at Vickers' Weybridge factory.

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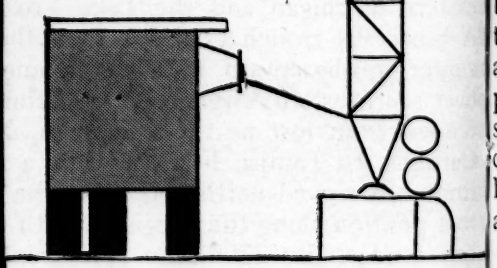

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in precipitation between 10,000 to 17,000 feet as a wave developed off the coast. Ceilings were forecast to be generally below 500 feet and visibilities less than two miles over the coastal waters and westward over Delaware, Washington, D. C., Maryland, and Virginia, to the Appalachians, including eastern North Carolina.

Flash Advisory No. 7 issued at 2130 at Washington, D. C., and valid from 2210 January 18 until 0210 January 19, indicated that over Virginia, Maryland, and Delaware, east of a line from Norfolk, Blackstone, Gordonsville, Virginia; Martinsburg, West Virginia; north to the Pennsylvania border, ceilings would be below 800 feet and visibilities one to three miles in occasional rain, drizzle, and fog. Conditions were expected to improve from the southwest. Frequent moderate and locally severe turbulence was forecast over and near the mountains of West Virginia, Maryland and Virginia.

Captain Fornasero was briefed by the company dispatcher via telephone on the weather conditions between Washington and Norfolk. He was given the 2030 amended terminal forecasts, the Washington Flash Advisory No. 6 valid until 2210, and four pilot reports. He was then given the 2100 sequence weather reports for Washington, Richmond, Newport News, Raleigh, Norfolk, Oceana, Norfolk Navy, and Patuxent River.

The refueling of Flight 20 was investigated to determine whether there might be a possibility of contamination or water ingestion into the fuel tanks during the last refueling activity. This investigation resulted in negative findings, insofar as could be determined by Bureau of Standards tests of fuel samples and by examination of the personnel and facilities of the refueling contractors.

Electric heating elements are built into the engine and oil-cooler air intakes of the Viscount as an ice-protection system. This system is controlled by switches on the roof panel of the cockpit. The system is not fully operative when on the ground, as a switch operated by the landing gear strut prevents overheating. With the switches in the "ON" position, the operation of this system is automatic.

Incorporated in the engine cowl ice-protection system is a thermostat for each engine. Each thermostat is located in the inlet duct of the cabin intercooler which is in the belly of the aircraft. In order to complete the electrical circuitry of this system, the arming switches in the cockpit must be placed in the "ON" position, and the outside air temperature must be plus 5°C or cooler. This temperature at the thermostat location will permit the thermostat to close a switch completing the circuit to the units.

Each individual thermostat senses outside air temperature and varies the heating from a rapid and short cycle (fast) to a slow and lengthened cycle (slow). The fast cycle of two minutes duration occurs between ambient temperatures of plus 5°C and minus 6°C; the slow cycle of six minutes duration occurs at temperatures below minus 6°C.

The four "ON-OFF" switches on the left side of the overhead panel which control the cyclic motor have a dual purpose. In addition to energizing the cyclic motor and thermostatic circuits, they also serve as thermal resets in the event of an overload or unbalanced element circuit.

A green indicating light is provided beneath each switch to indicate the status of the cyclic motor and element circuits. When the circuit is normal with balanced elements and the cyclic motor is operating, the green light will glow continuously, varying in intensity as elements cycle "ON" and "OFF". At temperatures between plus 5°C and minus 6°C (fast cycle), the lamps will glow bright for three seconds, and dim for 1½ seconds. At temperatures below minus 6°C (slow cycle), the lamps will glow bright ten seconds and dim for five seconds.

The heating elements of the power unit ice-protection system are designed to melt off ice in small pieces, which normally have no noticeable effect on operation when they enter the engine. However, if ice is allowed to build up to a considerable thickness before being removed, large pieces of ice enter the engine. The resultant high concentration of water may cause a partial or complete flameout.

A partial flameout, i.e., one or more combustion chambers extinguished, or a complete flameout will be indicated by reduction of torque pressure and jet pipe temperature (JPT).

Tests conducted during the development of similar Dart engines disclosed that the engines would flame out from ingestion of from 3.5 to four pounds of airframe ice, which is equivalent to the release of between a ¼ and ½ inch thickness of ice from the inside part of the nose cowling.

Prior to July 1958, the operation of the ice-protection system of the Viscount was initiated or armed when the outside air temperature was at plus 5°C. Because of the experience of several operators of Viscount aircraft, and because the temperature sensing on early aircraft was located in the aircraft nose section and was subject to compressibility error, temperatures at which the system would be armed were changed in July of 1958. After that date the prescribed procedure was to turn the system "ON" whenever the outside air temperature dropped to below plus 10°C. This modification, known as Change 15 of the Air Registration Board (ARB) Manual, had the sanction of the United Kingdom ARB and became a mandatory change for all United States air carriers using Viscount aircraft.

Change 15 also established the following procedure should icing conditions be encountered before the ice-prevention system could be switched "on."

- **Switch 'ON' ice-protection systems** on Engines 1 and 3.
- **Observe that the cycling lights** indicate **correctly.**
- **If both engines run normally** for three minutes, switch 'ON' the ice-protection systems on Engines 2 **and 4.**
- **If descending into air conditions** where the temperature is above 0°C indicated, it is advisable to discontinue the descent until all four engines are running normally, i.e., for six minutes."

The Capital Airlines Flight Manual did not include the information about selective de-icing of engines that had accumulated a buildup of ice prior to arming the ice-protection system, nor did it make note of the inadvisability of descending into temperatures above 0°C until the ice-protection system had been turned on and the engines operated normally for a period of at least six minutes. In fact, the checklist in effect at the time of the accident directed the pilot to descend to warmer air to de-ice his engines normally.

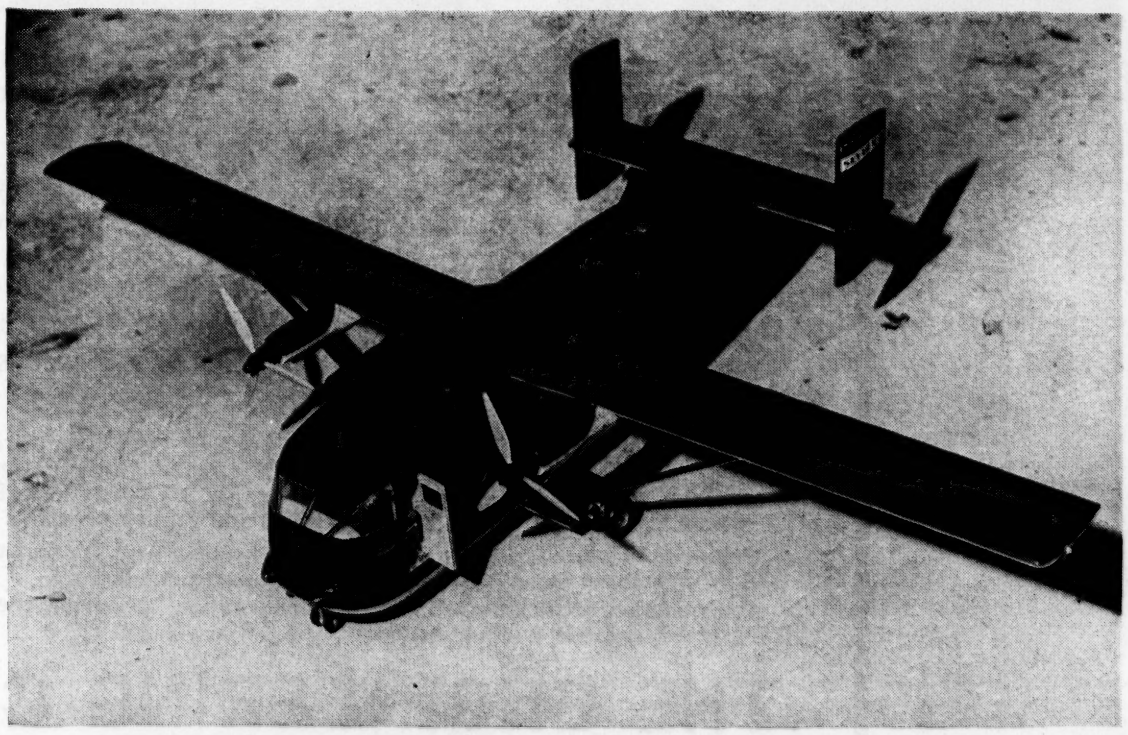
This checklist, effective March 26, 1957, reads as follows:

"*Flame Out—In Icing Conditions*

"1. Feather propeller

"2. Relight immediately, or descend below the freezing level to allow the engines to de-ice naturally."

Each of the four engines of the Viscount is equipped with a propeller that incorpo-



Skyvan II to Have Astazou Turboprops

British Short Skyvan II, designed for military and rough field operations, will be powered by two Blackburn Astazou turboprop engines developing 530 shp. each. The aircraft grosses at 11,500 lb. and has an aft loading door. It will carry up to 15 combat troops or can be used as an ambulance. The Skyvan II will fly in late 1962. Skyvan I is in advanced stages of construction at Belfast.

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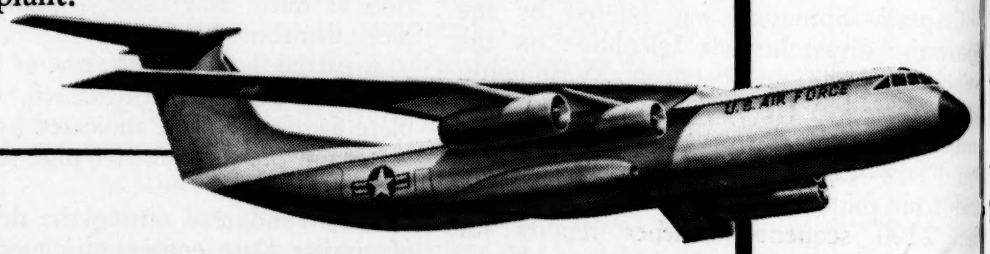

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rates an individual auto-feathering feature. The propellers will auto-feather at any time the throttle setting is calling for an engine output of 13,400 r.p.m. or above and there is a loss of torque below 50 p.s.i. During the relight sequence, if the throttle should be moved from idle to cruise before the engine r.p.m. reaches 13,400 r.p.m., and/or the torque does not build up to 50 pounds p.s.i., the propeller will return to feather.

If the throttles are retarded to a point below 13,400 r.p.m. and a flameout occurs, the propeller will simply windmill. Under this condition, if the throttles are then advanced to a position above 13,400 r.p.m. the propellers will auto-feather.

If an attempt is made to relight by actuating the unfeather switch, but without closing the high pressure cock and throttle, the propeller will not unfeather.

The propeller can be manually feathered by moving the high pressure valve lever to the feather position and then depressing the feather switch for each engine. When the feather/unfeather switch is manually pulled, the feather pump operates to supply oil pressure to unfeather and the air-relight circuit is energized to start the high energy igniters for 30 seconds.

Subsequent to the accident, a flight test was conducted in a Viscount 700 series aircraft in an effort to establish the average battery life of the type used aboard N 7462 when no generator power is available and while approximating the electrical load which was believed to have been carried at the time the emergency occurred. The flight test revealed that, with the four generators "OFF" and a continuous electrical load of over 500 amps., presumed to be about the same electrical load as that of the flight involved, the aircraft battery would fall, within 1½ to two minutes, to below the required voltage necessary to successfully unfeather a propeller and relight its engine.

The flight test further revealed the comparative airspeeds required to drive the propellers out of feather by windmilling. Approximately 150 knots of airspeed were required to drive the outboard No. 4 propeller out of feather, and approximately 180 knots of airspeed were required to drive the inboard No. 3 propeller out of feather position.

Analysis

Shortly after departing from Washington, Capital Flight 20 would have been in the clouds and would have remained in the clouds during a substantial portion of its climb to the cruising altitude of 8,000 feet. While the aircraft probably was out of clouds a portion of the time en route, it is considered that it was in clouds more than half of the time or approximately 10 to 15 minutes. During this period and prior to descent near the accident site, the aircraft would have been experiencing subzero temperatures. At the same time, Flight 20 would have encountered light and occasional moderate showers.

Cloud tops along the route were generally from 10,000 to 13,000 feet and could well have been lower locally. Ceilings ranged mostly between 100 and 400 feet with visibilities five miles or less in fog. Clouds were layered with the base of the upper deck about 6,000 feet and the tops of the lower deck between 3,000 and 4,000 feet. Drizzle was associated with the fog at a number of locations, while rain showers of varying intensity occurred along the route.

A small but intense low-pressure system and its associated frontal structure moved northeastward from south of the accident site to a location about 35 miles east-southeast of the site at the time of the accident. This system was accompanied by high gusty winds, heavy showers, turbulence, and some thunderstorm activity and hail. Pilot reports, radar reports, and groundwitness statements indicated quite clearly that the latter weather conditions affected neither the immediate area of the accident site nor the route from Washington to the accident.

The freezing level in the Washington area was near 5,000 feet, while the temperature at 8,000 feet was minus 8°C. The temperature at 8,000 feet over the accident site was approximately minus 4°C, and the freezing level was near 6,000 feet.

Upon descending below 6,000 feet near the accident site Flight 20 would have encountered temperatures above freezing. The aircraft would have broken out of the upper cloud deck at this altitude and would have entered the lower clouds at about 3,000 to 4,000 feet. From this altitude to ground impact the aircraft would have been in clouds with the possible exception of the final 100 to 400 feet. Light-to-moderate turbulence would have been encountered.

(This is the first half of the Civil Aeronautics Board accident investigation report on the crash of a Capital Airlines Viscount Jan. 18, 1960, near Charles City, Va. The concluding portion will be published in a future issue of AVIATION WEEK.)

New

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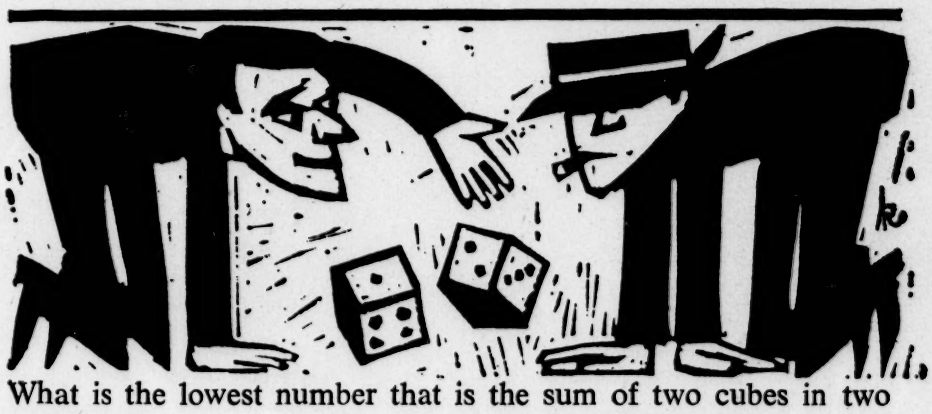

What is the lowest number that is the sum of two cubes in two different ways? —*Contributed*

The RA-1651 signal-actuated magnetic tape recorder from the Westrex division of Litton Systems, Inc. records at the drop of a voice, automatically stamps the time and date directly on the tape. Operates at a tape-conserving speed of five-eighths inch per second. Details are in an illustrated four-page brochure. Ask for Bulletin 3.2 at: Westrex Recording Equipment Department, 335 No. Maple Dr., Beverly Hills, Calif.

ANSWER TO LAST WEEK'S PROBLEM: There are no primes in this series. Consider the first nine numbers, the highest of which is 987,654,321. Eliminating even numbers and the five ending, leaves those ending in 9, 7, 3, and 1. But the digital sum of each is either 9 or 6 making them all divisible by 3. Next, any number higher than this number will repeat the same digital sums since the digital sum of this ninth number is 9.

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AVIATION WEEK, OCTOBER 9, 1961

AER-O-COM 102
AIRCRAFT POROUS MEDIA, INC. A SUBSIDIARY OF PALL CORPORATION 55
AIR PRODUCTS, INC. 64
AIRWORK CORPORATION 78
AMERICAN AIR FILTER COMPANY, INC., DEFENSE PRODUCTS DIVISION 63
AMERICAN MACHINE & FOUNDRY COMPANY, GOVERNMENT PRODUCTS GROUP 60-61
AMERICAN MISSILE PRODUCTS COMPANY, INC., A DIVISION OF DORSETT ELECTRONICS, INC. 83
AVIATION WEEK & SPACE TECHNOLOGY...106-107

BELL AEROSYSTEMS COMPANY DIVISION OF BELL AEROSPACE CORPORATION..... 31
BENDIX ECLIPSE-PIONEER DIVISION, THE BENDIX CORPORATION 52-53
BENDIX PIONEER CENTRAL DIVISION, THE BENDIX CORPORATION 65
BENDIX SCINTILLA DIVISION, THE BENDIX CORPORATION 3
BENDIX SYSTEMS DIVISION, THE BENDIX CORPORATION 20
BRUSH INSTRUMENTS DIVISION, CLEVITE CORPORATION .....3rd Cover

CONTINENTAL MOTORS CORPORATION..... 5
CUBIC CORPORATION 10

DE HAVILLAND AIRCRAFT OF CANADA LIMITED 57
DELAVAN MANUFACTURING COMPANY, FUEL INJECTION DIVISION 66
DONNER SCIENTIFIC COMPANY..... 62

FAIRCHILD SEMICONDUCTOR CORPORATION.. 16
FMC CORPORATION ORDNANCE DIVISION..... 54

GARRETT CORPORATION, THE—AIRSEARCH MFG. DIVISIONS 11
GENERAL ANILINE & FILM CORPORATION, ANSCO DIVISION 94
GENERAL ELECTRIC COMPANY, CAPACITOR DEPARTMENT 4
GENERAL ELECTRIC COMPANY, DEFENSE SYSTEMS DEPARTMENT 92
GENERAL ELECTRIC COMPANY, LIGHT MILITARY ELECTRONICS DEPARTMENT 13
GENERAL PRECISION, INC. 46-47
GRUMMAN AIRCRAFT ENGINEERING CORPORATION 58-59

HOWELL INSTRUMENTS, INC. 74

INTERNATIONAL NICKEL COMPANY, INC., THE 9

KAYNAR MANUFACTURING COMPANY, INC., KAYLOCK DIVISION .....2nd Cover

LEACH CORPORATION 86-87
LING-TEMCO-VOUGHT, INC. 6
LIQUIDOMETER CORPORATION, THE 96
LITTON INDUSTRIES, INC. 105
LITTON SYSTEMS, INC., A DIVISION OF LITTON INDUSTRIES 70
LOCKHEED GEORGIA COMPANY, A DIVISION OF LOCKHEED AIRCRAFT CORPORATION.... 104

MAGNAVOX COMPANY, THE—GOVERNMENT & INDUSTRIAL DIVISION 68
MAGNETIC CONTROLS COMPANY 18
McDONNELL AIRCRAFT CORPORATION..... 98
McGRAW-HILL BOOK COMPANY, INC..... 100

NORDEN DIVISION, UNITED AIRCRAFT CORPORATION 8
NORTHROP CORPORATION 85

PARSONS COMPANY, THE RALPH M..... 72
PRATT & WHITNEY AIRCRAFT DIVISION, UNITED AIRCRAFT CORPORATION..... 42
PRECISION LAPPING COMPANY INC..... 105

RAYTHEON COMPANY, ELECTRONIC SERVICES DIVISION 32
REPUBLIC AVIATION CORPORATION..... 90
ROLLS-ROYCE LIMITED 44
RYAN AERONAUTICAL COMPANY..... 80

SCOTT AVIATION CORPORATION..... 49
SELENIA, S.P.A. 95
SIEGLER CORPORATION, THE..... 82
SIMMONDS PRECISION PRODUCTS, INC..... 7
SPERRY GYROSCOPE COMPANY DIVISION OF THE SPERRY RAND CORPORATION..... 14
STATHAM INSTRUMENTS, INC..... 84
STEWART & STEVENSON SERVICES, INC..... 113

TABER INSTRUMENT CORPORATION, AEROSPACE ELECTRONICS DIVISION..... 97
TEXACO INCORPORATED 40
TIMKEN ROLLER BEARING COMPANY, STEEL & TUBE DIVISION 12

UNITED TECHNOLGY CORPORATION, A SUBSIDIARY OF UNITED AIRCRAFT CORPORATION 75, 93
UNITED TRANSFORMER CORPORATION..... 73

VAPOR HEATING CORPORATION, VAP-AIR AERONAUTICAL DIVISION 77
VARIAN ASSOCIATES, TUBE DIVISION....4th Cover

WRIGHT DIVISION OF SPERRY RAND CORPORATION 79

CLASSIFIED ADVERTISING

F. J. Eberle, Business Mgr.

WHERE TO BUY
Amalgamated Steel Corp. 112
Mercury Air Parts Co. Inc..... 122
EMPLOYMENT OPPORTUNITIES 108-111
NOTICES
Legal 112
EQUIPMENT
(Used or Surplus New)
For Sale 112

ADVERTISERS INDEX

Boreas Corporation 112
Careers, Inc. 108
General Electric 110
International Business Machines Corp..... 111
Lenkurt Electric Corp. 108
Vertol-Boeing 109

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LETTERS

Kudos for Dornberger

Congratulations to Dr. Dornberger for his excellent article (AW Sept. 18, p. 57) and to AVIATION WEEK for printing it. Amidst our national defense panic it is not often one comes upon such clear, concise thinking. Of course, the article will probably be disregarded by responsible government parties. Let's face it, the pure logic and simplicity will stagger them.

J. C. DEMOTT
Atlanta, Ga.

In response to the flood of mail which I am sure you will receive in "righteous rebuttal" to Dr. Dornberger's excellent article in the Sept. 18 issue of AVIATION WEEK I would like to add one word—Bravo! Bravo, for a man who believes what he says—and says what he believes!

I am, and have been for a long time, an ardent and, at times, a vocal adherent of the principles and ideas advocated by Dr. Dornberger. I have been critical of ex-President Eisenhower for (1) his statement that "there is no military use for space;" and (2) for the same ex-president's absolute disregard of the psychological and propaganda value to be derived from U. S. achievements in space.

Like Dr. Dornberger, I feel that our systems are and probably will continue to be "over-sophisticated" and, too, that we are always and forever encumbered by frustrating and agonizing delays of the "decision-makers." Delays that lose the precious time we can never regain.

In regard to the latter point, I think that President Kennedy (I am a Republican, incidentally) has enough alert and aggressive young men at his command to break through the communications barriers and produce these urgently needed decisions on a much more realistic time scale. Let us hope so.

There are many of your readers who will brand Dr. Dornberger's article as typical "German warlike reasoning." Since America is, and I for one hope it will remain, a free country, then these people can and must be heard. But I would like to see a recap of the percentage of pro versus con mail you receive on this subject.

As an average American, I am now paying, at my present income level—married, no children—about $7,000 per year in income taxes. If circumstances, embracing Dr. Dornberger's ideas, should dictate greater government spending, I will cheerfully shoulder my portion of any increased tax burden. I believe most other thinking Americans will do the same.

I would like to borrow from American sports parlance to state that the Russians are right now proving that the "best defense is a good offense." I can think of no earthly reason why we Americans cannot and should not become as Dr. Dornberger advocates, as aggressive and "offensive" as hell!

That will certainly be something the Russians can understand.

MORRIS M. ARNOLD
North Andover, Mass.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Explanation Wanted

Relative to your article entitled "Space Patent Rules Facing Challenge" by George C. Wilson in the Aug. 28 issue of AVIATION WEEK AND SPACE TECHNOLOGY (p. 26), further explanation is requested.

The statement "An AVIATION WEEK study indicated that only a fraction of the inventions made under NASA research contracts actually are reported to the space agency" is a challenging one. If you have actual evidence of inventions made but not reported, that is one thing, but if the statement is a presumption based on the reporting you discuss, the statement may be questioned.

Since NASA defines "inventions" to include "innovations" and "improvements," the "inventions" reported are a function of each establishment's interpretation of "innovations" and "improvements" and the respective background of the people there involved.

How many "reasonably patentable" inventions will NASA's 331 "inventions" support?

You would put this reporting matter in better perspective if you pointed out the peculiarities of NASA's requirements.

LAMONT B. KOONTZ, Attorney
Aero Patent Department
Minneapolis-Honeywell Regulator Co.
Aeronautical Division
Minneapolis, Minn.

Imagination Gap

The recent air show at Tushino demonstrates that while we in the United States have been arguing about the merits of manned bombers the Soviets have been busy designing and building improved models. No doubt we must await a Soviet flyby of a squadron of B-70 type aircraft before we turn our own on-again-off-again development into a weapon system crash program. Needless to say, such a crash program will end up costing far more than an orderly development initiated at the proper time. In those days we can turn to writing letters and editorials about the "bomber gap."

Actually, nothing would be more ironic than that the Soviet Union should take the lead in development and production of manned bombers.

This is because:

1. We have had a significant lead in this field. No excuses can be made about a late start.

2. Our military posture requires manned bombers to a far greater extent than the Soviet. This is because we openly publish the location of our military installations, whereas the Russians (strange, Oriental minds) keep theirs secret. Thus, we have far more need for attack vehicles capable of locating and discriminating targets than do they.

We are fortunate, indeed, to have a Congress sufficiently resolute to appropriate funds to keep our manned bomber capability at a high level. Perhaps the workings of our democratic process will pull us through after all—despite the "imagination gap" of the Pentagon budgeteers.

O. PRUSZANOWSKI
Cambridge, Mass.

A few years ago, when the Russians announced they were scrapping "obsolete" manned aircraft and were concentrating on missiles, we essentially followed suit. When Tushino came up, many manned aircraft projects suddenly found themselves back in the money. When the Russians stopped testing nuclear bombs, we also stopped. Is it not about time we started thinking for ourselves? The Russians are doing what they believe is best for Russia. It does not necessarily follow that this is best for the United States. Do we not have people who can make decisions rather than follow the Russian lead? The idea of putting a Russian as adviser to our President is preposterous, yet isn't this exactly what we have?

Much of the criticism aimed at the "man on the moon" project is based on the uselessness of such a venture; although several excellent reasons exist, the main argument used is that if we don't get to the moon the Russians will get there first. Big deal. If that is the only reason, by all means let the Russians get there first; then what will they do? Certainly, it is important that we get to the moon, but surely not simply because that's what the Russians are doing.

There is no question that we should know what all our opponents are doing and that we should design our offensive and defensive weapons to match theirs, but this should not become our obsession. Instead of having our entire defense philosophy change every time a Russian leader makes a speech or the Russians hold an air show, our goal should be to have them spend vast sums of money and effort matching our weapon systems.

GEORGES FRIPPEL,
New Brunswick, N. J.

Design Competition

Your article entitled "Ryan Builds Solar Collector Model" in the Sept. 18 issue, p. 59, does not mention that the model was fabricated as part of a concentrator design competition conducted and funded by Sundstrand Aviation-Denver. Sundstrand is developing a 15-kw. solar dynamic space power system under U. S. Air Force Systems Command contract AF 33/616/7128.

ROBERT BOYER, JR.
Sales Manager
Sundstrand Aviation-Denver